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ABSTRACT

A set of techniques is presented to assist administrators in forecasting the need for primary and secondary school facilities and in critically evaluating proposals to satisfy that need. The four basic components--enrollment, facility, fiscal, and geographic--presented in EA008632 are adapted for school districts without access to a computer and require only a desk calculator. Forms for manual calculation of the components are included. Two additional chapters present considerations for (1) organizing a major planning project and (2) selecting alternative plans, assembling data, and periodically rerunning the system. The same glossary and bibliography accompany each of the three documents in the set. (Author/MLF)

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School Facility Planning System

USER'S HANDBOOK: MANUAL VERSION

prepared by

ST. LOUIS RESEARCH CONSORTIUM

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Preface

The School Facility Planning System has been developed to assist public school administrators in their planning for educational space. The System has been made possible by a grant from the National Science Foundation to a consortium of institutions in St. Louis, Missouri. To date the System has had relatively limited test experience. All users who identify deficiencies in the procedures or documentation are encouraged to notify the Executive Director of the Council of Educational Facility Planners, 29 West Woodruff Avenue, Columbus, Ohio, 43210; and/or the Director of Planning, St. Louis County Government Center, Clayton, Missouri, 63105.

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Chapter 5 GEOGRAPHIC COMPONENT

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These 37 forms are presented in the final section of this handbook.

Executive Summary

Most school administrators appreciate the problem of long-range facility planning. Recent fluctuations in school enrollments, facility standards, and financial resources have emphasized the need for a structured and systematic approach to educational planning. The School Facility Planning System presents a set of techniques for persons confronted with elementary and secondary public school planning decisions.

Purpose. The School Facility Planning System is designed to assist administrators in forecasting the need for primary and secondary school facilities and in critically evaluating proposals to satisfy that need. Two versions are offered; one is designed for the district with easy access to a computer, the second requires only a desk calculator. When used by school personnel with a knowledge of local conditions, the System should provide a rational environment in which to consider the closing or construction of school buildings.

Components. Four basic components have been developed that allow the analysis required to project future conditions and test alternative proposals.

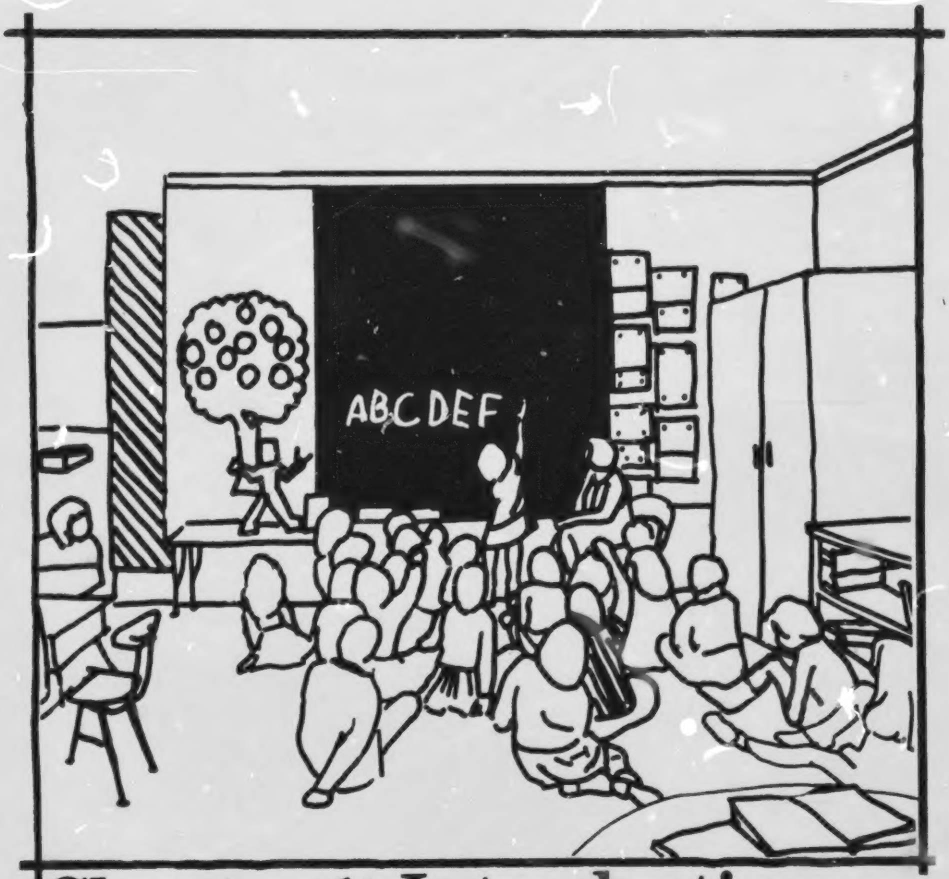
1. Enrollment Component. This component assists the user in forecasting the "demand" for public school education. The number and geographic location of students by grade may be forecast for each year over a long-range planning period.
2. Facility Component. This component translates projected students into the number of teaching stations and/or square feet necessary to house them. Calculations are designed to reflect the district's unique standards and policies regarding school operations. A comparison of existing and planned space with projected needs establishes the anticipated excess or shortage of space.
3. Fiscal Component. This component helps the user in forecasting bonding

capacity, tax revenue from different levels of government, and expected operating and capital costs. The fiscal implications of alternative facility plans may be examined and compared.

4. Geographic Component. This component assists the user in considering locational questions, how best to draw attendance boundaries, and where to build or close a facility. The transportation "costs" associated with alternative plans are calculated in light of the projected enrollment for different sub-areas of the district.

Two additional chapters are provided for those administrators desiring further insight into the facility planning process. Considerations are presented for organizing a major planning project (Chapter 6), and for selecting alternative plans, assembling data, and periodically re-running the system (Chapter 7).

Capability. The School Facility Planning System will not automatically improve the quality of long-range capital planning decisions. As with most planning tools, the utility of the product will be highly dependent upon the assumptions that enter into each calculation. The System must be used by individuals with an understanding of local demographic and economic conditions and of acceptable school board policies. However, when such individuals can be assembled, the System should enable a more rigorous and comprehensive planning process than has been previously possible.



Chapter 1: Introduction

The American public spends billions of dollars annually for the construction and modernization of public school facilities. In recent years, the form of these capital expenditures has begun to change as school closings have become as prevalent as openings and school remodeling has competed with new school construction. Many districts that until recently were growing in both population and assessed valuation have leveled off. Others that stabilized in the late 1960's are in the midst of a significant enrollment decline. Alternative approaches to local public education continue to be explored with emphasis on new curricula, instruction techniques, and forms of school organization. All of these factors have direct implications for school facilities. Thus, capital planning and budgeting for school systems in the years ahead will continue to be characterized by uncertainty.

1.1 The School Facility Planning System

The School Facility Planning System (SFPS) is a method for helping school administrators work in an environment of uncertainty. Developed under a National Science Foundation grant, this system represents the effort of a research consortium, consisting of a local planning agency, a computer-oriented consulting firm, the departments of urban studies and education at a university, and an architectural firm.*

The System has been reviewed by a 19-member review committee that included school administrators, representatives of related professional organizations, and several academic and private consultants. It has also been evaluated by a number of local school systems, primarily in the St. Louis, Missouri, area.

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*N.S.F. Grant GI—43109 was awarded to St. Louis County, Missouri, in May, 1974, in response to N.S.F. Program Solicitation Number 73-27. The project began in June, 1974 and terminated in October, 1975.

The following document explains the procedures for using the manual version of the School Facility Planning System. Interested readers are referred also to the computer-based version (SFPS Volume 2) and to the final comprehensive report (SFPS Volume 3) The latter document contains a detailed description of:

Project Organization. The process by which the project was organized and carried out, including a review of the research phases, the resources used, and the individuals and agencies interviewed.

State of the Art An overview of public school planning as practiced today, based on a review of current literature and questionnaires received from state departments of education and local education administrators

System Components. A detailed review of the specific techniques selected for inclusion in the system.

Systems Utilization. A review of different ways of using the system, with emphasis on interpreting the results.

1.2 Systems Capability

A successful capital improvement plan depends on an accurate appraisal of several supply and demand factors. The number and location of required school facilities will depend ultimately on the number of expected students and the quality of education considered appropriate for them. These projected requirements must then be evaluated in light of the existing facilities and the ability to pay for the development and operation of new facilities. The likelihood of unacceptable deterioration of existing facilities, of growth in the tax base, and of the passage of bond issues or tax rate increases must all be considered.

Given the diversity of necessary considerations, it is understandable that long-range capital improvement plans have traditionally been difficult to prepare. Such plans have often failed as a result of forecasts based on crude techniques and unwarranted assumptions. For example, extrapolations of prior enrollments or assessed valuation growth rates often have failed to recognize the saturation limits within a community. In other situations the problem has resulted from unique events, such as the location of a highway or the loss of a major government contract, events which could not have been foreseen.

The ideal school planning system would monitor all migration into and out of the district, and all changes in the district's tax base. Based on this information, it would yield highly accurate long-range forecasts of district needs and resources. For most school systems such forecasts are not possible. What is possible is a systematic set of procedures for forecasting future conditions and evaluating the impact of specific proposals in light of those conditions. This is what the School Facility Planning System attempts to provide.

The ultimate decision to close or build a school will usually depend on the school district's approach to risk, and particularly its perception of the dangers of over-estimating or under-estimating projected trends. In a situation where nothing can be absolutely certain as to the number of future students, the standards which will apply to their education, or expected revenues and expenses, the school board must evaluate the cost of making a poor capital planning decision versus making a decision to postpone constructing or closing a facility. These costs will vary with the situation. In a growing district the decision to build a school sooner than necessary (i.e., based on a higher than realistic enrollment forecast) may prove wise if the facility ultimately would be necessary. Such a decision would minimize crowding and would save funds that might otherwise be lost to inflation if the district had waited on its decision. However, if after the decision to build, the enrollment trends actually peaked, stabilized, or declined, an unneeded school would have been constructed.

Similarly, in a district with declining enrollment, the costs of a bad estimate must be considered. The decision to sell an unnecessary school may prove wise if enrollments continue to decline. On the other hand, should future enrollment levels stabilize and begin to climb again, a much wiser decision would have been to lease or moth-ball the unnecessary school until it was required again.

The School Facility Planning System cannot determine the school administrator's or school board's position on such unquantifiable issues. Such positions must be adopted subjectively. The System can, however, provide an administrator with a range of likely future conditions based on selected assumptions. It also provides a mechanism for evaluating policies designed to address such conditions.

1.3 **System Components**

The School Facility Planning System is a series of distinct components, each requiring certain information inputs and producing certain information outputs. Some of the components are further broken into specific system modules. Figure 1-1 presents the interaction of these components. Once a project is identified, most users will develop enrollment projections, followed by facility, fiscal, and geographic analysis. However, the System has been designed so that a component may be skipped which is of no interest, or for which information has been acquired from an independent source. In addition the user has the ability to re-analyze any component, using a new set of assumed input variables. Each component contains a general description of its purpose and design, followed by a set of specific procedures, which are printed on colored paper to facilitate reference to them. Examples of all calculations have been included on forms at the end of the document. Several blank forms are also presented which can be reproduced.

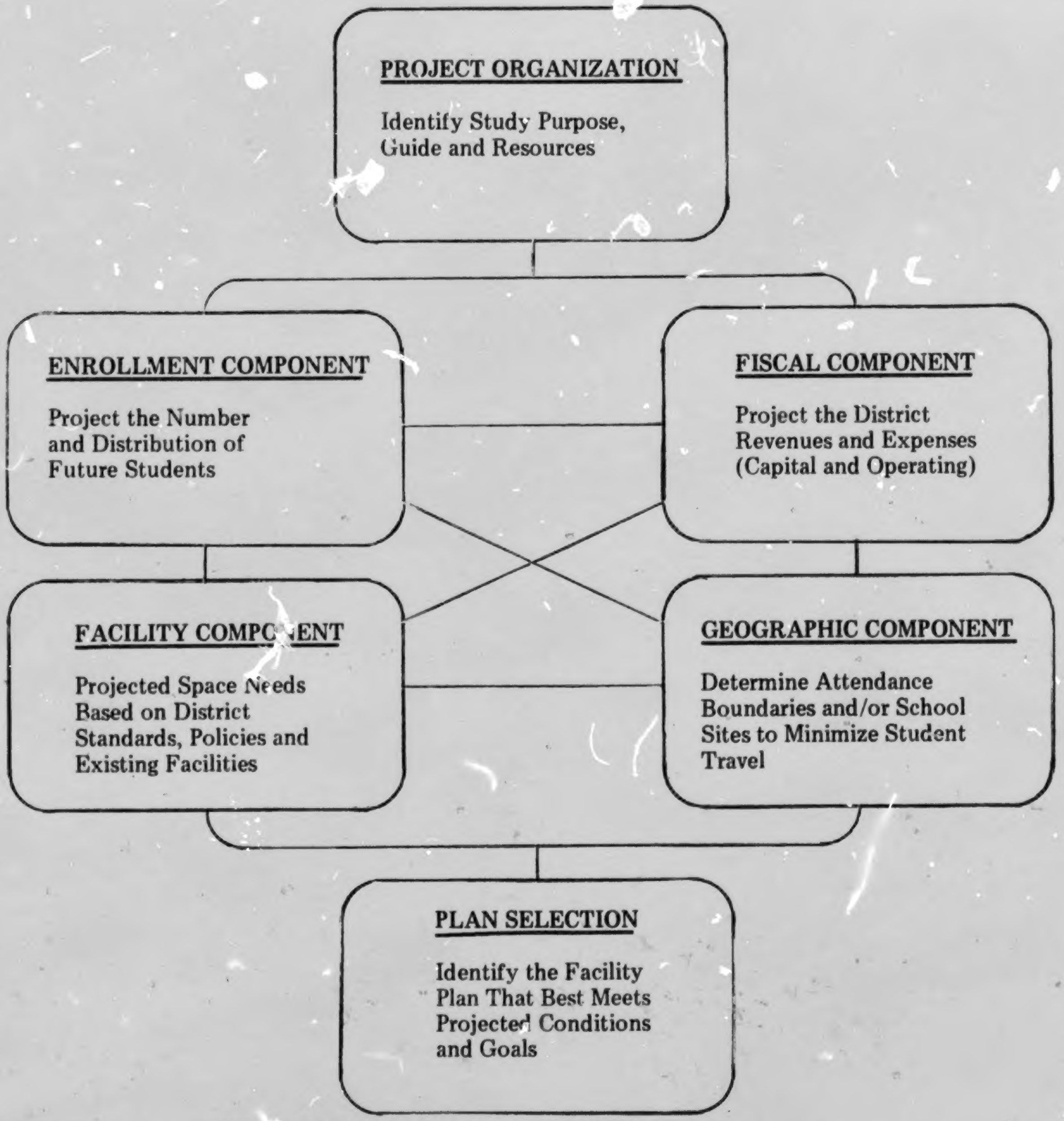

PROJECT ORGANIZATION
Identify Study Purpose, Guide and Resources
ENROLLMENT COMPONENT
Project the Number and Distribution of Future Students
FISCAL COMPONENT
Project the District Revenues and Expenses (Capital and Operating)
FACILITY COMPONENT
Projected Space Needs Based on District Standards, Policies and Existing Facilities
GEOGRAPHIC COMPONENT
Determine Attendance Boundaries and/or School Sites to Minimize Student Travel
PLAN SELECTION
Identify the Facility Plan That Best Meets Projected Conditions and Goals

FIGURE 1—1 SCHOOL FACILITY PLANNING SYSTEM

1.3.1 Project Organization

Prior to the initiation of any analysis, the school system must conduct some basic organizational activity. Depending upon the scope of the project, this will usually include the assembly of a study team, review of the overall district situation, and some initial decisions as to the version of the School Facility Planning System that will be used (i.e., manual or computer-based). The level of detailed analysis to be conducted must be determined, as must the available data sources which might be used. These and other organizational considerations will be familiar to many school planners. Those individuals wishing to review the many steps that enter into the planning process are encouraged to read Chapter 6, "Project Organization," before initiating the study.

1.3.2 Enrollment Analysis

The first analytical component projects future public school enrollments. These projections will vary with the number of families expected to live in the community and their characteristics in terms of family size, income, religion, and other social and economic factors.

As described in Chapter 2, the manual version of the School Facility Planning System recommends that several forecasting techniques be considered. The traditional cohort survival or grade progression technique is suggested for those districts needing specific forecasts for grades over a short-or medium-range time span. An extrapolation technique may also be appropriate for extending time series data on a linear or non-linear basis. For longer range forecasts in an area where reliable independent population projections already exist, the ratio method may be applicable. The ratio method can also serve as a quick check on the enrollment totals produced by some other technique.

Communities characterized by rapid expansion or reduction of their housing stock may want to consider the dwelling unit method. This approach requires forecasts of future numbers of dwellings and future students per dwelling. It, as well as the other techniques, may be supported by a district-wide census or enumeration.

In addition to the district-wide projections, sub-area forecasts may be desired by certain school districts. Chapter 2 provides a method of projecting "regional" enrollments and then allocating those totals to smaller "areas" within each region. This geographic dimension will enable the attendance boundary adjustment and site selection procedures that are described in Chapter 5. Techniques for projecting racial composition and adjusting projections for unique events within a district also are presented.

1.3.3 Facility Analysis

The next step is to determine the ability of the school system, given its existing and expected school plant, to house the projected students. The Facility Component is used to translate projected students into the actual space required to serve them. This needed space can be measured in square feet, teaching spaces, or both. When compared to the district's existing space, an indication is given of the projected shortage or excess of facilities. Chapter 3 describes the formula which yields the specific space requirements and provides the forms and instructions necessary to make the calculations. The user is presented with the option of examining facility needs on a district-wide basis, a school-by-school basis, or, where necessary, a subject-by-subject basis. While the input data varies, the basic formula remains the same in all situations.

School capacity varies significantly, depending upon the district's standards and policies. The Facility Component encourages the district to examine the impact of changes in the desired utilization rate, sessions policy, students per teaching space, and grade organization. Temporary adjustments in one or more of these variables may eliminate the need to construct or close a building. Chapter 7, "Planning Considerations," reviews many of the alternatives that a school system may want to examine in its efforts to reduce the gap between expected space needs and actual capacity.

1.3.4 Financial Analysis

Any tentative building program must be evaluated in light of its fiscal impact. Thus Chapter 4, "The Fiscal Component," provides the ability to forecast expected revenues and expected expenditures in light of any school facility configuration. The component allows the district to examine the following elements:

Capital Resources. The user is provided with the ability to calculate current and future bonding capacity in light of projected changes in assessed valuation and possible new bond issue efforts.

Future Revenues. The user is provided with the ability to forecast revenues from different levels of government that will be available for both operating and capital requirements.

Future Expenditures. The user is provided with the ability to project the future costs associated with any building program and to evaluate those costs in light of expected revenue.

Long-range fiscal analysis is especially difficult because of the impact resulting from national and state, as well as local conditions. Future assessed valuation will fluctuate with residential, industrial and commercial building rates and prices, and local reassessment policies. Revenue will vary with local tax base trends and tax rate decisions, state allocation formulas, and national legislative programs. Expenditures will reflect national inflation and interest rate conditions, as well as local construction costs, teacher contracts, and other specific situations. Throughout the Fiscal Component the user is encouraged to consider alternative assumptions regarding probable revenues and costs.

1.3.5 Geographic Analysis

The final component addresses the question of location. Previous analysis has considered the need for more or fewer schools and the district's ability to pay, but not the important questions as to where a school should be opened or closed and who should attend that school. Chapter 5 will assist the districts in considering two important locational issues:

Site Selection. The user is provided with a technique for determining the general location of school sites within a district that would minimize transportation costs in light of long-range enrollment projections.

Attendance Boundaries. The user is provided with a technique for designating the attendance boundaries of existing schools so as to minimize transportation costs and improve racial balance.

Geographic analysis can be extremely complicated, given the diversity of special considerations that must be taken into account. In addition to the projected location of students, examination must be made of the path of a railroad, major street artery, or limited access highway; historical attendance areas; bussing policy; and local political attitudes. Because of this complexity the manual version of the School Facility Planning System presents a relatively simple method, but one which requires considerable insight and common sense on the part of the user.

Collectively the four components present a versatile set of techniques that can be applied to many kinds of school planning problems. Experienced administrators with a clear idea as to the scope and focus of a problem to be analyzed should not examine those chapters describing the relevant components. Users with less clearly defined planning problems should review all chapters, starting with Chapters 6 and 7 and skipping over the procedures sections of each component. All potential users are encouraged to consider ways of dealing with "uncertainty" as outlined below.

1.4 Projections Under "Uncertainty"

By itself the School Facility Planning System will not provide all the necessary answers. While it can be supported by quantitative techniques, school planning is essentially more an art than a science. The problem of obtaining additional school space or finding use for excess space would be difficult enough if the school administrator's perception of future conditions were completely accurate. As this is not the case, the planning process is more complicated.

Every forecast generated in the following components will be based on certain assumptions and will be subject to statistical forecasting errors. Future enrollments will deviate from the projected levels as birth rate and migration patterns vary. School system standards and policies may also change as educational philosophies and goals evolve. Existing facility conditions will change because of age, vandalism, and other unforeseen events. Costs and revenues will fluctuate with national and local economic conditions and voter attitudes.

The success of the planning effort will depend largely on the quality of the assumptions on which the projections are based. These, in turn, must rest upon the judgement and intuition of the individuals on the school planning team. Their combined perception of subjective probabilities are critical to the formulation of a relevant plan.

The analysis of a problem under conditions of uncertainty requires that a distinct set of procedures be followed: the options available for gathering information must be listed; the possible events that could occur must be considered; the probability that any particular event will occur must be evaluated; and preferences for alternative courses of action must be stated. It is important that the decision maker seek a course of action consistent with his personal judgements and preferences and that he consciously monitor the consistency of his subjective inputs and their implications for action

1.4.1 Confidence Intervals

Anyone making the statement that a single forecast of population, fiscal resources, or any other variable will be 100 percent accurate either believes he has an audience of fools or is fooling himself. Very few forecasts have been "right on the money." Placing an upper and lower limit on forecasts represents a traditional technique for gaining more confidence in the projections which are derived. Confidence intervals can be determined objectively by using established statistical procedures, or subjectively by making reasonable assumptions.

Statistical procedures exist for calculating the probability that the mean of a population will fall within a certain interval based on the statistical variation and the relative size of a sample of that population. For example, given the heights of 100 of the 400 sixth grade children within a hypothetical school district, one could calculate a confidence interval or band based on the variance in height of the 100 sixth graders and the size of the sample population relative to the total population. This interval might be calculated so that there would be a ninety-five percent chance (or some alternative, depending on the desired confidence level) that the average height of all 400 sixth graders would fall within that confidence band.

At first glance these statistical procedures might seem useful to school facility planners in their calculation of enrollment or fiscal projections. However, since confidence intervals must be based on the variance in historical data, one would, in effect, be assuming that the variance in future data would be the same as it has been. If, as in the above example, the variance in the data was known, it could be said with 100 percent certainty that the confidence band would offer a ninety-five percent chance that the mean of the total population would fall within the band. But when, as in the case of projections, the variance in the data is not known, the above statement no longer applies. No longer could a planner be certain that a given confidence band would offer the desired confidence level. Even though the historical data might suggest that a projection would fall within, for example, plus or minus thirty students of the actual number ninety-five percent of the time, in reality the impact of future conditions might insure that this range was only an eighty percent confidence interval. Stated another way for any given projection there might be only a fifty percent chance that plus or minus thirty students would in fact constitute a ninety-five percent confidence band.

In situations that require forecasting, subjectively determined upper and lower limits offer more useful guidelines with which to work. Several precautions must be taken into consideration when determining these upper and lower limits. In most cases the upper limit should not be determined by assigning maximum values to all the variables involved in the forecast. This would result in a grossly exaggerated limit because of the fact that there is very little chance that all the variables incorporated in the forecast would reach their maximum values in the same time period. A more realistic approach would involve assuming maximum feasible values for each variable, one at a time. The resulting forecasts would be recorded to determine which variable had the most influence on the forecast. After making a subjective assertion as to those variables most likely to obtain their maximum values, an upper limit could be derived, using maximum values for the variables identified as most volatile and influential. The same procedure could be followed to determine a lower limit, beginning with minimum feasible values for each variable.

Regardless of whether a confidence interval is determined statistically or subjectively, it should be noted that the forecast certainty will vary inversely with time. Therefore a confidence band must expand over time to maintain any given confidence level. This infers that a point in time exists beyond which the certainty of a forecast, including its confidence band, is so diminished as to render it worthless for planning purposes. A second factor must also be considered in the process of making projections, the length of the planning period.

1.4.2 Planning Period

If there were no uncertainty associated with enrollment and fiscal forecasts, the planning period would usually extend to the normal life of a school building. A facility that could be used for forty years would be designed and located in light of forty-year forecasts. However, because forecasting error increases, often exponentially, with time, such a long-range time frame will rarely make sense. The question is how far into the future a forecast should be made before it is considered useless.

Since the life of most school facilities will exceed the time beyond which a forecast will have totally lost its reliability, the planning period will usually be shorter than the life of a building. In situations involving new construction it might be advantageous to match the planning period with the bond or loan retirement period so that the projected utility of the building would extend for at least as long as the time for which the building was being paid. In some cases this also may be an unattainable goal since a normal debt retirement period of twenty years may often exceed the period for which an enrollment forecast is reliable. One constraint that should be observed in establishing the minimum length of a planning period is the capital construction time. A planning period should extend at least as far into the future as the time necessary for fund raising, land acquisition, and construction of the facility. Otherwise, a building could become obsolete before it was ever occupied.

The determination of an outer limit to the length of the planning period requires subjective considerations regarding forecasting error. Assume that an enrollment forecast of plus or minus thirty students from the actual total enrollment was believed acceptable for a hypothetical school district. Further assume that a decision was made not to use forecasts extending beyond that point in time where there was less than a 50-50 chance of maintaining the above confidence interval. Based on characteristics particular to an individual school district, considerations could be made to determine how far into the future the certainty of a given confidence interval would be maintained.

This approach defines "uncertainty" as the probability of exceeding predefined confidence intervals for a given projection. If, for example, the hypothetical school district had experienced steady enrollment growth and there were no indications that this trend would vary significantly, the school planner might judge that forecasting error would increase by only two percent per year. Beginning with the current year, where "uncertainty" is zero, the "uncertainty" factor could be compounded two percent a year until fifty percent "uncertainty" was reached, thus delimiting the planning horizon. For the first year in the planning period there would be only two percent "uncertainty" that the enrollment projection would not fall within thirty students of the actual enrollment. In the second year of the planning period, using the formula $(1+u)^n -1$, where u is the percent change in "uncertainty" per year, and n is the year of the planning period "uncertainty" would equal $(1.02)^2 -1$, or 4.04 percent. This progression would continue until year twenty when "uncertainty" would reach 48.6 percent The planning period based on a two percent change in "uncertainty" per year would be twenty years. If conditions in the school district were such that a five percent increase in "uncertainty" per year appeared more likely, the planning period would be cut almost in half, as shown in Figure 1-2.

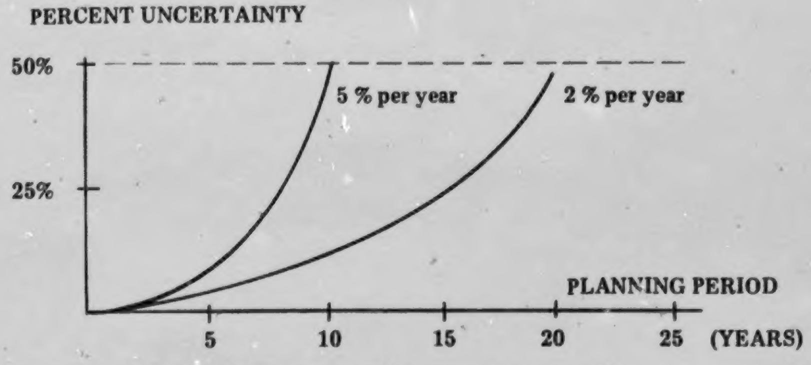


FIGURE 1—2 ALTERNATIVE PLANNING HORIZONS

In addition to the deterioration in forecasting confidence, a second factor may be important in establishing the planning period. Many users will want to consider the cost of making a mistake. Even in situations that are unstable to the degree that no confidence is warranted in the forecasts beyond a few years, it may be desirable to examine the consequences of a decision if certain unexpected events, and hence projections, did materialize.

This approach is based on the premise that while it is often not possible to make long-term projections with any certainty, the ease or difficulty of dealing with alternative "scenarios" can be examined. If the cost of being unprepared for a particular set of enrollment or fiscal conditions was great, the district might want to retain options for dealing with this eventuality, despite the probability of its occurrence being small. Users concerned with the consequences of possible enrollment or fiscal conditions may want to extend the planning period beyond that point for which there is reasonable certainty regarding specific projections. In most cases a minimum ten-year planning period is recommended.

1.4.3 Decision Focus

Once the length of the planning period has been established, the school planner must focus attention on when during the planning period facility changes should take place. Relevant subjects for consideration are the direct relationship between forecast error and time, economies of scale, interest rates, and building cost inflation.

Since one can be more confident in the accuracy of short-range as opposed to long-range forecasts, it follows that planning facility changes to meet immediate demand will be safer than building far ahead of projected demand. If the years of the planning period were ranked according to an "uncertainty" schedule such as those developed above, attention would focus on the earlier years in the planning period. For example, a fifteen-year enrollment forecast for a hypothetical school district might dictate the need for a 2,000 student capacity facility at a particular location by the twelfth year of the planning period. Construction of the facility early in the planning period, far ahead of demand, could offer the best facility mix over the entire period if the enrollment projections proved to be accurate. But the uncertainty schedule for this district might indicate the enrollment projections during the last years of the period to be so indefinite that it was deemed unwise to build the entire facility. Instead, a smaller facility might be approved in a different location designed to serve the demand forecasts for the first five years of the period.

Economies of scale. The relative accuracy of short-range forecasts is only one of the factors which must be considered in the timing of facility decisions. Economies of scale constitute a second factor; however, in the school planning context, this concept cannot be assigned its traditional meaning. Normally, economies of scale measure different levels of output corresponding to facilities of different size. Unfortunately there is no easy way to measure educational output. One can judge, but not measure, whether the size of a facility has any bearing on the quality of education offered. For purposes of school facility planning, economies of scale can only be measured in terms of operating and building costs for facilities of different size. Given this qualification some users may choose to estimate potential savings due to economies of scale in the following manner:

1. Collect construction cost data on various large and small facilities within the district or metropolitan area. To the extent possible these should be characterized by a similar level of amenities.
2. Correct the construction cost figure of each facility for inflation using the following formula:

$$\frac{X}{CCI_B} = \frac{CC_D}{CCI_D}$$

where:
X = construction cost corrected for inflation,
CCI_B = local construction cost index in the base year (usually 100),
CCI_D = local construction cost index for the period in which the facility was built, and
CC_D = actual dollar amount of the construction costs.

3. Divide each inflation corrected construction cost by the floor space for the associated building. This will result in a dollars-per-square-foot figure for each facility. Comparison of these figures should indicate which schools, large or small, have historically been more economical to build in the area.
4. Another economy of scale consideration involves operating costs, including custodial and administrative overhead. Personnel and maintenance costs must be allocated to each

school according to staffing patterns. Then divide the operating expenses of each school in the district by the corresponding number of square feet of floor space for each school and compare the figures. This may reveal any economies of scale in the operating expenses for facilities of various size.

The above information will provide a second guideline for the timing of facility changes. Consider the previous example, where a long-range forecast dictates the need for "x" amount of additional space. The additional space could be built in stages with the construction of several small facilities to hedge against the possibility of a downturn in the demand for space. Or one large facility could be constructed which would have the required additional space for the entire period. If the economies of scale associated with the large building outweigh the uncertainty of the long-range forecast, then the larger facility should be built in advance of projected demand.

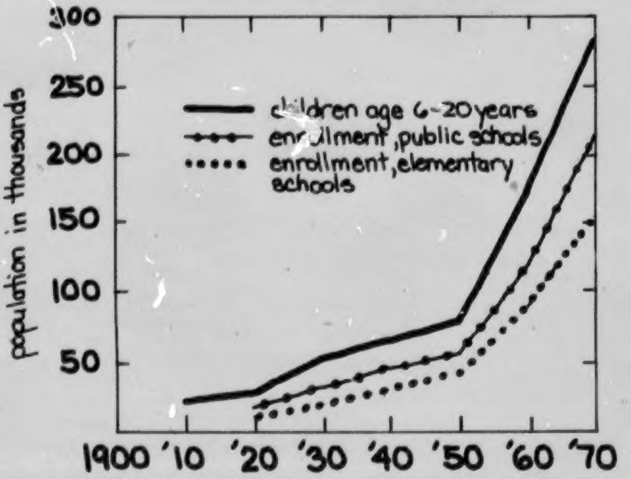
Interest Rates. Interest rates, or the cost of money, is a third factor that should relate to the staging of planned facility changes. Bonded indebtedness has traditionally been the common source of revenue for financing school facility construction and modernization. Interest rates on municipal bonds may vary as much as one percent within a year. Additional rate variation may occur depending on the type of bond, size of the issue, and bond rating of the issuing authority. The probable direction of long-term interest rates and the district's bond rating will have to be analyzed. If it is suspected that interest rates will increase (and/or the bond rating fall), there will be pressure to build sooner rather than later. Alternatively if there is a chance that the bond rating may increase in the future (and/or interest rates may fall), then there may be an incentive to postpone construction. A combined increase or decrease in interest rates and bonding rating could offset each other, thus offering no guidance in deciding when to build.

Inflation. The effect of building cost inflation must be considered in conjunction with interest rates and the district's bond rating. The basic question is whether the impact of inflation on a school district's expected revenues will be comparable to the impact on construction costs. Several possibilities exist. Costs and revenues could increase or decrease at the same rate, resulting in no incentive to build at one point in time over another. Costs could rise at a slower rate than revenue, in which case postponement of construction would be favored, or vice versa.

Differences in the cost of money and construction must also be considered. An evaluation will be especially difficult when material and labor costs are expected to rise in conjunction with falling interest rates. An attempt should be made to estimate when, and if, rising material and labor costs will offset potential savings due to declining interest rates.

1.4.4 Summary

Subjective assertions are necessary in every category of school planning. A major element in the success of any planning effort will be the knowledge and understanding that each planner has of a particular school district. Confidence intervals can assist in the forecasting effort and should play a role in determining the length of the planning period. Once the planning period has been identified and the projections made, judgements regarding uncertainty, economies of scale, interest rates, and inflation must all be considered jointly in the timing of facility changes.



*based on reports published by the Superintendent of St. Louis County Public Schools

SCHOOL AGE POPULATION AND PUBLIC SCHOOL ENROLLMENT 1900-70*
ST. LOUIS COUNTY

Chapter 2: Enrollment Component

The objective of this chapter is to assist in the forecasting of future public school enrollments. Procedures are provided for the development of forecasts for total school system enrollment levels, enrollments in each grade, the geographic distribution of enrollments, and the racial composition of future public school students.

2.1 Overview

The general approach emphasized throughout the chapter is based on the assumption that no statistical forecasting technique is adequate unless it is tempered by professional judgement and experience that recognizes the unique characteristics of an individual school district. Projections generated by the procedures in this chapter should not, therefore, be accepted without reservation or modification. These forecasts should be viewed as an initial baseline from which to deviate when conditions are not sufficiently explained by the assumptions inherent in the procedures used.

Section 2.2 includes four distinct techniques which may be used for forecasting total school system enrollment levels. The basic rationale of each technique is described briefly and the associated computational procedures are outlined in this section.

The cohort survival technique is presented first. This method is generally used as a short-range forecasting tool (i.e., one-to-five years). It is based on the calculation of a series of survival rates, each of which indicates the fraction of students in one grade in a given year who 'survive' to the next grade in the next year. The survival rates will thus encompass all of the individual factors influencing enrollments, such as migration and retention rates. Enrollments in the initial grade are estimated independently on the basis of past birth data. This technique may be particularly appropriate for school districts where the principal source of uncertainty as to future enrollment levels can be attributed to changes in the birth rate or the age distribution of the population, and where other factors such as migration rates are expected to remain stable or continue to change at the same rate as they have in the past.

The second technique is entitled time trend projections. This method also lumps the effect of individual phenomena together and simply extrapolates the specified enrollment trend. An advantage of this technique is that the user is allowed considerable freedom in the selection of an appropriate trend curve. Therefore, the projections are not entirely constrained to an exact replication of past trends, but reflect the user's perception of the most likely pattern of future enrollments.

The ratio method is presented next. Forecasts derived using this technique are based upon currently available projections of trends for some larger region of which the local school district is a part. In general larger regional forecasts are more reliable than forecasts for a small geographic area. Thus, if the relationship between the larger area and the local school system is reasonably stable, this technique may be useful in deriving longer range forecasts.

The dwelling unit multiplier technique is the fourth method presented for projecting total school system enrollments. This technique involves the generation of separate forecasts of future dwelling unit growth (by type of dwelling) and of the yield of public school enrollments applicable to these dwellings. This method may be especially appropriate in growing school districts where a major portion of the enrollment growth is expected to stem from future residential development.

The user is encouraged to examine these techniques carefully to determine those which may be appropriate in each school system. It is further suggested that several techniques be utilized. Comparisons of several forecasts which have been derived independently using different techniques may provide valuable insights into future enrollment patterns. If these forecasts are quite similar, the associated uncertainty may be of less significance. If they are very dissimilar, it may be possible to locate the source of the discrepancy and thus avoid the possibility of relying on forecasts which are based upon an invalid set of assumptions. The task of reconciling several sets of forecast values is discussed at the end of this section.

Of the four enrollment forecasting techniques presented in Section 2.2, only the cohort survival technique specifically derives estimates of enrollments by grade. Section 2.3 thus contains a method whereby an estimate of enrollments in each grade may be generated. A modified formulation of the cohort survival technique is used to allocate the total enrollments which have been previously forecast to various individual grade levels.

Section 2.4 is concerned with the geographic distribution of future enrollments. Two levels of geographic detail are considered. In the first part of this section, projection techniques for relatively large regions within the school system are considered. These regions are defined as the largest areas within a district about which generalizations can be made concerning past and expected future densities and growth patterns. Each region thus defined will consist of relatively homogeneous neighborhoods. The suggested forecasting approach for these regions is simply to reiterate the most appropriate of the total enrollment forecasting techniques, using input data which pertains only to that region. The second part of Section 2.4 involves the allocation of total regional enrollments (or system wide enrollments if no regional breakdown has been undertaken) to a number of smaller areas contained in the region. The enrollment in each of these smaller areas is initially forecast, using a modified dwelling unit multiplier technique. These initial area forecasts are then adjusted so that they conform to the forecast for the region, as it is assumed that these regional forecasts are more reliable than forecasts derived for the smaller areas.

The racial composition of future enrollments is examined in Section 2.5. The approach suggested in this section involves a reiteration of any of the previous procedures, substituting wherever appropriate non-white enrollment data for total enrollment information.

The last section of this chapter, Section 2.6, briefly looks at the uncertainty associated with the enrollment forecasting. An attempt is made to measure the extent of this uncertainty by presenting a procedure for calculating confidence intervals for the initial forecasts. This procedure involves the reiteration of previously described procedures, using reasonable expectations of the likely high and low values which various inputs might take in each year of the planning period.

None of the techniques included in this chapter can adequately handle all of the multitude of possible contingencies. Adjustments should be made to the basic forecasts wherever it is possible to anticipate and quantify any future conditions which might cause the actual enrollment level to deviate from the forecast value. This adjustment process is discussed in the second part of Section 2.6.

Prior to the execution of the procedures contained in the balance of this chapter, an appropriate planning horizon must be chosen. The length of the planning period may be influenced by the specific forecasting technique chosen. However, as stressed in the first chapter, many additional factors should be considered.

Capital planning and budgeting is essentially a long-range activity. The user is therefore encouraged to consider a planning period of at least ten years for enrollment forecasting purposes. While the degree of uncertainty will increase rapidly as forecasts are extended farther into the future, some measurement of long-range demands should be attempted.

2.2 Total Enrollment Forecasts

Four techniques are presented below for projecting the total number of students within a school district: cohort survival, time series analysis, the ratio method, and the dwelling unit method.

2.2.1 The Cohort Survival Technique

The cohort survival (or grade progression) technique is the most commonly used enrollment forecasting method. The data requirements are not extensive and the necessary computations are relatively simple and straightforward.

2.2.1.1 General Design

This forecasting technique involves the calculation of a series of 'survival rates' which reflect the proportion of students in a given grade and year who progress or 'survive' to the next higher grade in the next school year. These rates may be calculated using the equation below:

$$SR_{i,i+1} = E_{i+1,\ j+1} \ / \ E_{i,j}$$

where SR represents the survival rate from grades i to i+1, and $E_{i,j}$ the enrollment in grade i in school year j. For example, suppose that there were three hundred (300) students enrolled in the fourth grade in the 1973-74 school year, and that there were two hundred and eighty-five (285) students enrolled in the fifth grade in the 1974-75 school year. The cohort survival rate in this case would equal 0.95 (i.e., 285/300) Survival rates are calculated similarly for several previous years. The average of these past survival rates is then applied to current enrollment data to obtain estimates of future enrollment levels. For example, suppose that the average survival rate for students progressing from grade four to grade five was calculated from historical enrollment figures and found to equal 0.97. If there were three hundred (300) students enrolled in the fourth grade in the current school year, then ninety-seven percent (97% or 0.97) of these students would be expected to 'survive' to the fifth grade in the next school year. The estimated enrollment in the fifth grade for the next school year would thus be two-hundred and ninety-one (i.e. 0.97 x 300 = 291). Average survival rates for each pair of consecutive grades may be similarly computed and applied to current enrollments to derive forecasts for each grade. These average survival rates may be further applied to subsequent years over the planning horizon so that enrollment forecasts may be generated as far into the future as desired.

All of the factors which may influence the progression of students from one grade to the next are lumped together and measured simultaneously by the cohort survival rate. These factors include migration patterns, drop-out, retention and death rates, as well as public versus private school preferences. For this reason, the survival rates may be either greater or less than one depending on the net effect of all such factors. The use of the cohort survival technique does not facilitate an examination of any of these factors individually. The use of the average of previous survival rates in the generation of forecasts implicitly assumes that historical trends in these factors will continue relatively unchanged.

Where this assumption is thought to be appropriate, the cohort survival technique should provide reasonably valid enrollment projections. However, in school systems where these factors are expected to deviate from patterns exhibited in the past, the use of this technique may result in serious forecasting errors. The user in this case should rely upon the cohort survival method only for that period of time over which such factors are expected to remain stable or continue to change at rates similar to those exhibited in the past. For this reason the cohort survival method is frequently used in generating short-range forecasts, from one to five years.

Cohort survival rates cannot estimate the initial grade enrollment for kindergarten or first grade. This task must be accomplished independently. The technique used here to forecast enrollments in the initial grade involves an examination of the historical relationship between the initial grade enrollment and the number of births which occurred five years previously. A six-year lag would be appropriate where kindergarten is not offered. Births occurring within the school district boundaries, or county-wide (or municipal) birth data, may be used. A 'birth survival' rate will be used to reflect the relationship between the two variables. This rate may be computed as follows:

$$BSR = E_{I,t} \;/\; B_{t-a}$$

where BSR represents the 'birth-survival' rate, $E_{I,t}$ represents the enrollment in the initial grade in year t, and B_{t-a} represents the number of births in year t-a, a being the average age of students enrolled in the initial grade. The average of birth-survival rates for several previous years may be applied to subsequent birth data to provide an estimate of future initial grade enrollments.

The relationship between initial grade enrollments and births occurring within the school system's boundaries should represent a more reliable predictive measure than would the relationship between initial grade enrollments and county births if, of course, these two jurisdictions are not contiguous. However, in cases where school system boundaries are not contiguous with a county or municipality, birth information may be unavailable or quite difficult to obtain. In addition, where county birth projections are likely to be available through some public agency, e.g., the county department of planning, school system projections may not be as readily available or as reliable. If school system births are available and forecasts of future births for this jurisdiction have been generated and are accessible, they should be used in the calculation of 'birth-survival' rates. If school system birth data is available but forecasts of these births are not, this measure may still be appropriate where the planning horizon of the user does not exhaust the historical birth data. The choice of the precise measure of births to be used in the calculation of birth-survival rates is left to the discretion of the user.

2.2.1.2 COHORT SURVIVAL PROCEDURES

This section presents a series of steps for projecting enrollments using the cohort survival technique. The necessary computations require the use of four forms. Examples of completed versions of these forms are illustrated at the end of this section. Data requirements are limited to historical enrollment information by grade and birth statistics. Birth projections are necessary when the planning period is to exceed five years.

Step 1. First determine the number of years of historical data which are to be considered in deriving the survival rates. No single criterion is appropriate in making this decision and hence the selection will, of necessity, be an arbitrary one. The user is encouraged to reiterate the procedures outlined in this section, using a varying number of previous years to determine the extent of any differences which might arise. If the enrollment forecasts vary greatly, depending on the amount of historical data used, this variation may indicate that the assumptions underlying the technique itself are inappropriate. The user in this case may wish to consider alternative forecasting techniques.

Label the years for which historical data will be considered at the top of Form A, with the earliest year at the far left and progressing consecutively to the current or most recent year at the right of this form. These same years should also be labeled at the top of Form B.

Step 2. Label the grades encompassed by the school system on Form A, beginning at the top with the highest grade and continuing down to the lowest grade at the bottom. These grades should be similarly labeled on Form D.

Step 3. Enter the enrollments in each grade for each year labeled on the corresponding lines of Form A.

Step 4. Calculate the survival rates and enter them into the boxes found on Form A. The number to be entered in each box may be computed by dividing the number on the line immediately to the upper-right of the box, by the number found on the line immediately to the lower-left of this same box. An example of this procedure is presented in Figure 2-1.

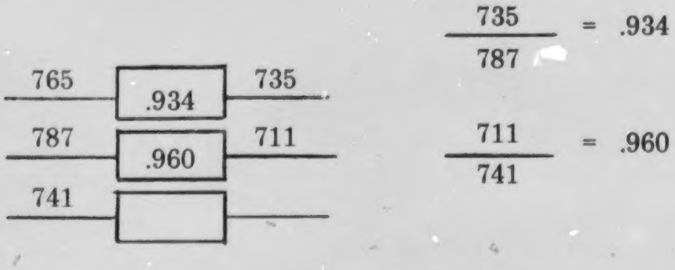


FIGURE 2—1 SURVIVAL RATE CALCULATIONS

Step 5. The average survival rate from one grade to the next is found by taking the average of each row of boxes on Form A. These averages should be entered in the last column on the right of Form A and in the first or left hand column of Form D.

Step 6. Enter enrollment in the initial grade, either kindergarten or first grade when kindergarten is not offered, on the first row of Form B for each of the years labeled.

Step 7. The age at which students enter the initial grade should now be subtracted from the years appearing above the first row in Form B and the results entered above the second row of this form.

Step 8. Enter the selected measure of births for each of the years indicated on the second row of Form B.

Step 9. Divide each of the values on the first row of Form B by the value on the second row. Enter the results on the third row of this form. These values represent the birth-survival rates.

Step 10. Compute the average of the birth-survival rates on the third row of Form B and enter the value at the bottom of the form.

Step 11. Label the years of planning horizon in the spaces provided directly above the second row of Form C, not including the current year, beginning with the first year of the forecast period at the far left and progressing consecutively to the last year of the chosen planning horizon.

These same years should be similarly labeled at the top of Form D, this time, however, beginning with the current year and continuing through the last year of the planning horizon.

Step 12. As was done in Step 7, subtract the age at which students enter the initial grade from the years appearing above the second row of Form C, and place the resulting values above the first row of this form.

Step 13. For each of the years indicated above the first row in Form C, enter on the first row the number of births, either using historical data, or forecast values where appropriate.

Step 14. Multiply each of the values found on the first row of Form C by the average birth survival rate found at the bottom of Form B. Enter the products on the second row of Form C. Enter these same values on the row corresponding to the initial grade enrollment found on Form D for each of the corresponding years over the planning period, beginning with the first year of the forecast period, i.e., the first, or far left, value on the row corresponding to the initial grade, should be left blank at this time.

Step 15. In the second column of Form D, enter the correct enrollments for each of the grades labeled.

Step 16. The forecast enrollments may now be estimated for each grade in each year over the planning period. Multiply the value found on any line in Form D by the average survival rate found in the far left-hand box on the same row, and enter the resulting product on the line immediately to the upper-right of the initial line. An example of this procedure is shown in Figure 2-2.

	647	625	566
.934	669	606	587
.938	646	626	570

.938 x 646 = 606

.934 x 606 = 566

FIGURE 2—2 FORECASTING ENROLLMENT USING AVERAGE SURVIVAL RATES

Step 17. Finally, calculate the estimated total enrollment for each year over the planning horizon. This is done by summing the values in each column of Form D and entering this sum on the last row of the form.

2.2.2 Time Trend Projections

A frequently used method of projecting total enrollment is simply to extrapolate the past trend. This may be done by statistically estimating the curve which appears to best fit the historical observations. Used in conjunction with a generous portion of sound professional judgement regarding future enrollment trends, this technique may represent a useful forecasting tool.

2.2.2.1 General Design

This technique requires that the user specify the general shape of the curve which is most likely to reflect the expected enrollment trend over the chosen planning period. The selection of a particular type of curve is more important in obtaining an accurate enrollment forecast than the statistical estimation of that curve. For this reason careful consideration should be given to all potentially important factors prior to making this selection. These factors would include expected birth rates, migration, retentions, dropouts, deaths, public versus private school preferences, and future housing patterns. Although not explicitly considered, expectations regarding all of these factors will influence future patterns of enrollment growth or decline and should be subjectively examined before specifying a particular curve type.

Once a specific type of curve has been chosen, the historical total enrollment data may be used to statistically estimate the exact configuration of this curve. The curve which has been thus fitted to historical observations can then be used to derive future enrollment estimates. The only data required is historical total enrollment figures, and in some cases, depending on the type of curve chosen, an estimate of the ultimate maximum or minimum level of total enrollment. Specification of these maximum or minimum values will once again require careful judgement on the part of the user.

The procedure to be used in the estimation of the 'best fit' curve is that of simple linear, or straight line regression. The total enrollment data is regressed against time. Since several of the curves presented are nonlinear, various data transformations are necessary. These transformations will depend on the nature of the curve type and are described below, as are the steps necessary to perform the regression procedures and the calculation of forecast enrollment levels.

Two fundamental tasks are involved in the generation of enrollment forecasts using time series projections: 1) The selection of a curve which is thought to be the most reflective of the future trend in enrollments, and 2) The actual computations involved in the statistical estimation of future enrollments. Three types of curves are presented below. The selection of a particular curve will determine which of the specific procedures should be executed.

2.2.2.2 Curve Selection Considerations

Each of the curves described below represents a different set of assumptions about the likely pattern of future enrollment growth or decline. The user should select the most appropriate of these curves, but is encouraged to repeat the procedures, using several different curves, in order to examine and evaluate their relative impact on the subsequent enrollment forecasts. These curves are grouped and presented according to the data transformations associated with their selection. Prior to the selection of a particular curve, the user should carefully graph the historical enrollment data. This will assist in the selection process by allowing a visual comparison of previous enrollment patterns with any potential future trend.

Type A: Linear Growth or Decline. The least complicated of potential future enrollment patterns may be represented by a straight line, as in Figures 2-3 and 2-4, which show examples of straight line growth and decline respectively. In both of these curves the rate of absolute change in enrollment is seen to remain constant. If past enrollment trends exhibit such straight line growth or decline, and if this same type of pattern is expected to continue over the chosen planning horizon, then this simple linear relationship may be the appropriate projection curve to use.

It must be cautioned, however, that the use of a straight line curve implies that the absolute rate of growth or decline will continue over the entire planning horizon. This may be a valid assumption, particularly where this rate of change is gradual, the curve does not slope steeply upward or downward, or where the planning horizon is relatively short. However, it should be kept in mind that in a school district with fixed geographic boundaries, enrollments are unlikely to increase or decrease without bounds. It is more likely that, in the case of growth, there is some reasonable upper limit beyond which the school district's enrollment will not pass. This limitation stems from the fact that there is a limit on the amount of land within the school district's boundaries which is available or suitable for residential development. A similar limit to the ultimate level of decline would be expected to exist. The straight line curve will usually be appropriate only in cases where the expected growth over the chosen planning horizon does not approach the upper limit of such growth, or where the expected decline does not approach the expected lower limit

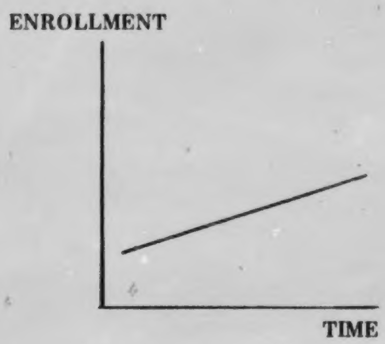


FIGURE 2—3 LINEAR GROWTH

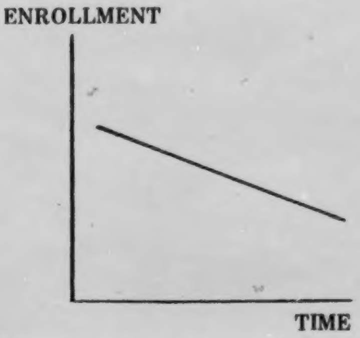


FIGURE 2—4 LINEAR DECLINE

Type B: Nonlinear Growth. All nonlinear growth patterns will be statistically estimated using a logistics curve. The general configuration of the logistics curve is shown in Figure 2-5. This curve is commonly used by demographers in forecasting population growth trends. It is based on the assumption that there is some upper limit to the ultimate level of population. A similar upper limit is likely to apply to school enrollments as well. The pattern of growth exhibited by the logistics curve is one in which the school system progresses through a period of rapid growth, but as the enrollment level approaches the upper limit to growth, the rate of growth begins to diminish and eventually becomes negligible.

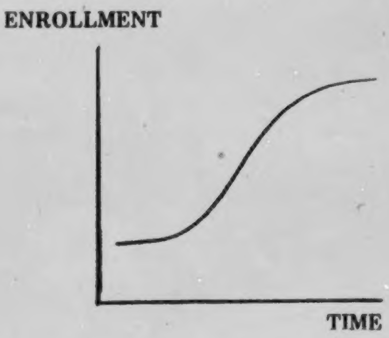


FIGURE 2-5 LOGISTICS CURVE

Though the historical enrollment trend may not appear to follow a logistic growth pattern, the logistics curve may still be applicable. Suppose, for example, that the historical enrollment data follows a pattern such as that shown in Figure 2-6. This growth pattern cannot continue unabated over any appreciable period of time. If it did, enrollments would reach unreasonably high levels. As the upper limit to enrollment is approached, the growth rate will begin to slow down, even though the absolute growth may occur beyond the chosen planning horizon. In this situation, the S shape of the logistics curve may not be evidenced, but it is nonetheless implied for some time period beyond the planning horizon selected for examination. A similar situation may occur where the historical enrollment data follows a pattern such as that shown in Figure 2-7. In this case, the rate of growth has already begun to diminish so that the period of very rapid growth is not in evidence. Again the logistics curve may be used to estimate this growth trend. The lower portion of the S curve will be implied even though it has not been exhibited by the available historical data.

If a nonlinear growth trend is thought to be the most reflective of historical and expected future enrollment levels, an upper limit to enrollment will need to be specified. This upper limit should be estimated in light of the amount of undeveloped, but developable, land remaining within the school district boundaries, the likely impact of future birth and death rates, the expected age distribution of the population, and so on. Because of the uncertainties involved in the specification of such an upper limit, the user is encouraged to repeat the procedures, specifying various values for this limit in order to examine the impact of changing the assumptions about the future characteristics of the school system.

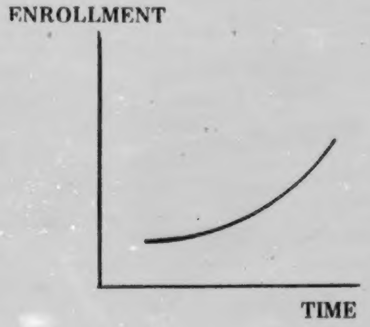


FIGURE 2–6 INCREASING RATE OF GROWTH

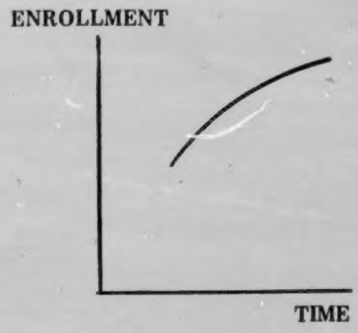


FIGURE 2–7 DECREASING RATE OF GROWTH

Type C: Nonlinear Enrollment Decline. Nonlinear, or curved, decline patterns may be statistically estimated with an inverted logistics curve which has a general configuration such as that shown in Figure 2-8. This curve is based on the assumption that enrollment decrease may not continue forever, but that the rate of decrease will diminish as the enrollment level approaches some lower limit. As in the case of the nonlinear growth curve, the historical trend may not appear to follow the inverted logistic decline pattern, but this curve may still be useful. Suppose, for example, that the historical enrollment data follows a pattern such as that shown in Figure 2-9. Clearly this rate of decline cannot be maintained for any appreciable length of time, or it would result in negative enrollment levels. The rate of decline must diminish at some point, even though this point may occur beyond the chosen planning horizon. Alternately the historical enrollment pattern may appear as in Figure 2-10. In this case, the rate of decline has already begun to decrease. The inverted logistics curve may still be used to estimate the remaining portion of the trend. The upper portion of the S curve will be implied even though it has not been evidenced by the available historical data.

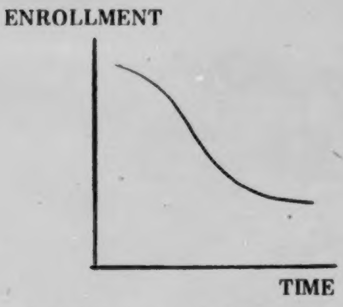


FIGURE 2–8 INVERTED LOGISTICS CURVE

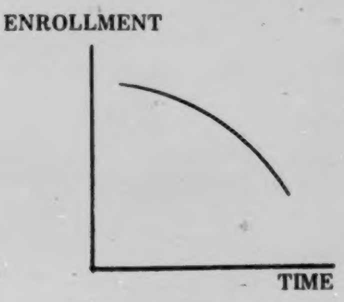


FIGURE 2–9 INCREASING RATE OF DECLINE

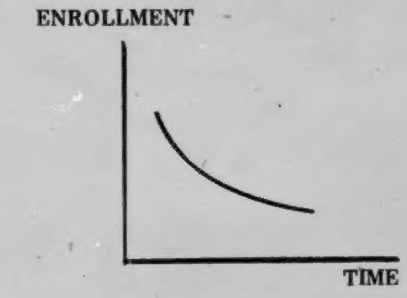


FIGURE 2–10 DECREASING RATE OF DECLINE

If a nonlinear pattern of decline is thought to be applicable, a lower limit to the level of enrollment must be specified. This lower limit should be estimated on the basis of expected future vacancy rates, community renewal plans, and demographic trends. Again the uncertainties associated with identifying a limit to enrollment decline should encourage the user to reiterate the procedures and to examine the impact of different values of this limit.

The three types of curves presented previously represent varying assumptions regarding future enrollments. The user should identify the particular curve type which is felt to be the most reflective of future trends in the school district and which is also consistent with historical enrollment patterns. Once a specific curve type has been chosen, the historical enrollment data is used to generate estimates of future enrollment levels.

2.2.2.3 TIME TREND PROCEDURES

The procedures to be followed using a time trend projection technique depend upon the nature of the curve which has been selected. Three separate forms, along with instructions for their completion, are included, one for each of the curve types described above. Historic enrollment figures and estimates of the upper or lower enrollment limits (for curve types B and C) constitute the only data requirements. An example of each technique has been prepared to help illustrate the use of the forms.

Type A: Linear Growth or Decline. Users who have chosen a straight line or linear curve to represent the expected enrollment growth or decline over the planning period should follow the instructions presented below for the completion of Form E.

Step 1. Select an appropriate number of historical observations to include in the subsequent calculations. It is suggested that between five and ten years of historical enrollment data be used. However, because Type A curves are linear, this decision should not be entirely arbitrary, but rather influenced by the nature of previous enrollment trends. For example, suppose that the past enrollment data was graphed and appeared as in Figure 2-11. If all the historical data were used, the estimated trend would resemble Line A in this figure. This is obviously not an appropriate trend line since it shows a continually increasing enrollment pattern, even though enrollments have decreased for the last five consecutive years. In the absence of other information, a continued enrollment decline would be expected. For this situation, only the last five years of data should be used because these years show the trend which the user expects to continue. If only the last five years of data were used, the estimated trend would resemble Line B in Figure 2-11, which appears to be a more realistic curve. The observed enrollment data should therefore begin with the first year in which the trend expected in the future is evidenced by the historical data.

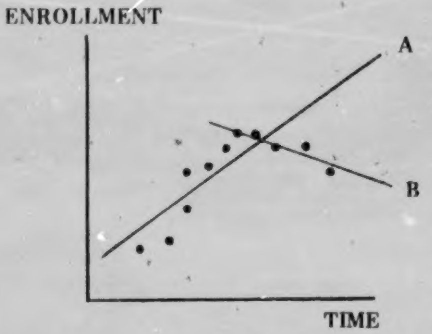


FIGURE 2–11 SAMPLE HISTORICAL DATA

The years included in the selected historical data set should be labeled on Line 1 (Form E), beginning with the earliest year and progressing consecutively to the current, or most recent, school year. The current school year must appear in Column 10. Where less than ten years of historical observations are used, there will be columns on the left-hand side of Form E which will be left blank.

Step 2. On Line 2 number the years for which historical observations are used, beginning with the first year.

Step 3. Compute the average of the numbers on Line 2 and enter this average in the space provided on Line 3.

Step 4. Subtract the value on Line 3 from each of the numbers on Line 2 and enter the results on Line 4.

Step 5. Square each number on Line 4 and enter the results on Line 5.

Step 6. Total the numbers found on Line 5 and place this total in the space provided on Line 6.

Step 7. Enter the total enrollment for each of the years identified in Line 1 on Line 7.

Step 8. Compute the average of the values found on Line 7. Enter this average in the space provided on Line 8.

Step 9. Multiply each of the values on Line 4 by the corresponding value on Line 7. Enter the resulting products on Line 9.

Step 10. Total the value on Line 9. Enter this total in the space provided on Line 10.

Step 11. Divide the value on Line 10 by the value on Line 6. Enter the result on Line 11.

Step 12. Multiply the value on Line 11 by that on Line 3. Enter the result on Line 12.

Step 13. Copy the values found on Line 1 onto Line 13. Beginning in Column 11, label each year over the planning horizon. Line 13 will thus contain the years covering the historical data period, as well as the years of the planning period.

Step 14. On Line 14 consecutively number (beginning with one) each of the years which are shown on Line 13.

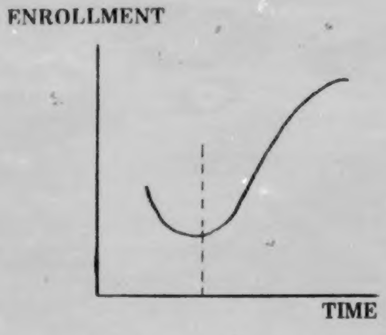
Step 15. Subtract the value on Line 12 from the value on Line 8. Enter this same number in each column of Line 15 (ignoring those columns on either the extreme right or the extreme left in which there is no corresponding value found on Line 14).

Step 16. Multiply each of the values on Line 14 by the value on Line 11. Enter the products on Line 16.

Step 17. Add each of the values on Line 15 to the corresponding value on Line 16. Enter the resulting values on Line 17. These values represent the estimated enrollment for each of the years identified on Line 13. The values through Column 10 will give an indication of how closely the fitted curve comes to approximating the actual enrollments. The values in the remaining columns, Column 11 on, represent the forecast level of enrollments for each year over the planning horizon.

Type B: Nonlinear Enrollment Growth. Users who have chosen a nonlinear growth curve to represent the expected enrollment trend should follow the instructions outlined below for the completion of Form F.

Step 1. Select an appropriate number of historical observations to include in the subsequent calculations. In general between five and ten years of historical enrollment data should be used. If, however, some substantial period or enrollment decline occurred at the beginning of any potential span of observations, as in Figure 2-12, the data for these years should not be used in this procedure.



OBSERVATIONS THROUGH
YEAR "A" ARE DISCARDED

FIGURE 2—12 SAMPLE HISTORICAL DATA

The years included in the selected historical data set should be labeled on Line 1 of Form F, beginning with the earliest year and progressing consecutively to the current, or most recent, school year. The current school year must appear in Column 10. Where less than ten years of historical data is used, there will be columns on the far left-hand side of Form F which will be left blank.

Step 2. On Line 2 number the years for which historical observations are used, beginning with the first year.

Step 3. Compute the average of the numbers on Line 2 and enter this average in the space provided on Line 3.

Step 4. Subtract the value on Line 3 from each of the numbers on Line 2 and enter the results on Line 4.

Step 5. Square each of the values on Line 4 and enter the results on Line 5.

Step 6. Total the numbers on Line 5 and place this total on Line 6.

Step 7. Enter the total enrollment for each of the years identified in Line 1 on Line 7.

Step 8. Enter the expected ultimate maximum enrollment level that it is believed the school district will achieve on Line 8.

Step 9. Divide the value on Line 8 by each of the values on Line 7. Enter the resulting values in the appropriate columns of Line 9.

Step 10. Subtract one (1.0) from each of the values on Line 9 and enter the resulting values on Line 10.

Step 11. Determine the natural logarithm of each of the values on Line 10 and enter these logarithmic values on Line 11. Natural logarithmic values of real numbers may be found in any handbook of mathematical tables.

Step 12. Compute the average of the values on Line 11 and enter this average on Line 12.

Step 13. Multiply each value on Line 11 by the corresponding value on Line 4. Enter these products on Line 13.

Step 14. Calculate the total of all of the values on Line 13 and enter this total on Line 14.

Step 15. Divide the value on Line 14 by the value on Line 5. Enter the resulting value on Line 15.

Step 16. Multiply the value on Line 15 by the value on Line 3. Enter this product on Line 16.

Step 17. Copy the values on Line 1 onto Line 17. Beginning in Column 11, label each year over the planning horizon. Line 17 will thus contain the years covering the historical data period as well as the years of the planning period.

Step 18. On Line 18 consecutively number, beginning with one, each of the years which are labeled on Line 17.

Step 19. Subtract the value on Line 16 from the value on Line 12. Enter this same value in each column on Line 19, ignoring, of course, those columns on either the extreme right or the extreme left in which there is no corresponding value found on Line 18.

Step 20. Multiply each of the values on Line 18 by the value on Line 15. Enter the products on Line 20.

Step 21. Add each of the values on Line 20 to the corresponding value on Line 19. Enter the resulting values on Line 21.

Step 22. Determine the natural antilogarithm of each of the values on Line 21. Enter these antilogarithms on Line 22. Antilogarithmic values of real numbers may be found in any handbook of mathematical tables.

Step 23. Add one (1.0) to each value on Line 22 and enter the resulting values on Line 23.

Step 24. Divide the value on Line 8 by each of the values on Line 23. Enter the results on Line 24. These values will represent the estimated enrollment for each of the years identified on Line 17. The values through Column 10 will give an indication of how closely the fitted curve comes to approximating the actual enrollments on Line 7. The values in the remaining columns, Column 11 on, represent the forecast level of enrollments for each year over the planning horizon.

Type C: Nonlinear Enrollment Decline. Users who have chosen to use the inverted logistics curve to represent the expected enrollment decline pattern should follow the instructions outlined below for the completion of Form G.

Step 1. Select an appropriate number of historical observations to include in the subsequent calculations. Again, between five and ten years of historical enrollment data should be used unless there was a significant period of enrollment growth which occurred at the beginning of any potential span of observations, as in Figure 2-13. Data for these years should not be used in the procedure.

In a subsequent step, the user will have to specify the maximum enrollment level for the school district. Since a Type C decline curve has been selected, this peak enrollment level should be easily identified from the historical data. The time period containing this peak enrollment level must not be included in the historical observations used in the subsequent operations of this procedure. In other words, the historical data set must begin in some time period after the maximum enrollment level was reached. If there are not a sufficient number of observations to make the exclusion of this peak value feasible, then the user should subsequently specify the maximum value as being equal to one hundred and one percent of the actual peak enrollment; i.e., multiply the peak enrollment by 1.01 and use the resulting product as the maximum.

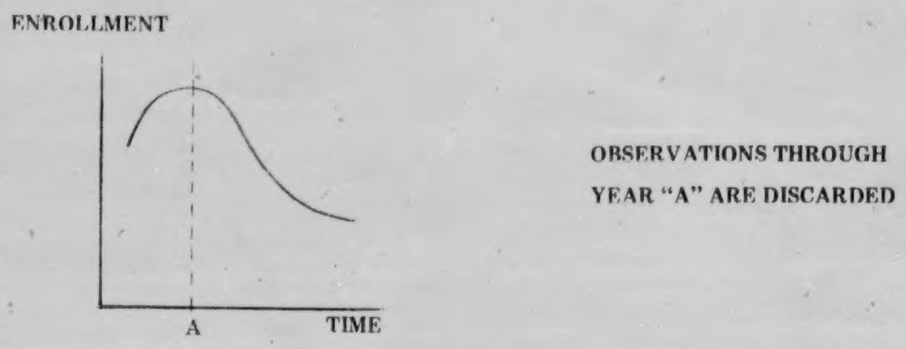


FIGURE 2—13 SAMPLE HISTORICAL DATA

The years included in the selected historical data set should be labeled on Line 1 of Form G, beginning with the earliest year and progressing consecutively to the current, or most recent, school year. The current school year must appear in Column 10. Where less than ten years of historical data are used, there will be blank columns on the far left-hand side of Form G.

Step 2. On Line 2, number the years for which historical observations are used, beginning with the first year.

Step 3. Compute the average of the numbers on Line 2 and enter this average on the space provided on Line 3.

Step 4. Subtract the value on Line 3 from each of the numbers on Line 2. Enter the results on Line 4.

Step 5. Square each of the values on Line 4 and enter the results on Line 5.

Step 6. Total the numbers on Line 5 and place this total on Line 6.

Step 7. Enter the total enrollment for each of the years identified on Line 1 on Line 7.

Step 8. Specify on Line 8 the expected lower limit to the future enrollment level.

Step 9. Subtract the lower limit on Line 8 from each of the values for enrollments on Line 7. Enter these values on Line 9.

Step 10. Enter the maximum enrollment level on Line 10.

Step 11. Subtract the value on Line 8 from that on Line 10. Enter the result on Line 11.

Step 12. Divide the value on Line 11 by each of the values on Line 9. Enter the resulting values in the appropriate columns of Line 12.

Step 13. Subtract one (1.0) from each value on Line 12. Enter the results on Line 13.

Step 14. Determine the natural logarithm of each of the values on Line 13 and enter these logarithmic values on Line 14. Natural logarithms may be found in any handbook of mathematical tables.

Step 15. Compute the average of the values on Line 14 and enter this average on Line 15.

Step 16. Multiply each value on Line 14 by the corresponding value on Line 4. Enter these products on Line 16.

Step 17. Calculate the total of all the values found on Line 16 and enter this total on Line 17.

Step 18. Divide the value on Line 17 by the value on Line 6. Enter the result on Line 18.

Step 19. Multiply the value on Line 18 by the value on Line 3. Enter this product on Line 19.

Step 20. Copy the values on Line 1 onto Line 20. Beginning in Column 11, label each year over the planning period. Line 20 will thus contain the years covering the historical data as well as the years of the planning period.

Step 21. On Line 21 consecutively number, beginning with one, each of the years which are labeled on Line 20.

Step 22. Subtract the value on Line 19 from the value on Line 15. Enter this same value in each column of Line 22, ignoring, of course, those columns on either the extreme left or the extreme right in which there is no corresponding value on Line 21.

Step 23. Multiply each of the values on Line 21 by the values on Line 18. Enter the products on Line 23.

Step 24. Add each of the values on Line 23 to the corresponding value on Line 22. Enter the resulting values on Line 24.

Step 25. Determine the natural antilogarithm of each of the values on Line 24. Enter these antilogarithms on Line 25. Antilogarithmic values of real numbers may be found in any handbook of mathematical tables.

Step 26. Add one (1.0) to each value on Line 25 and enter the resulting values on Line 26.

Step 27. Divide the value on Line 11 by each of the values on Line 26. Enter the results on Line 27.

Step 28. Add the value on Line 8 to each of the values on Line 27. Enter the resulting values on Line 28.

These values represent the estimated enrollment for each of the years identified on Line 20. The values through Column 10 will indicate how closely the fitted curve comes to approximating the actual enrollments on Line 7. The values in the remaining columns, Column 11 on, represent the forecast level of enrollments for each year over the planning period.

2.2.3 The Ratio Technique

The ratio technique is an alternative method for projecting local school district enrollments based upon projections of the population or enrollment for some larger geographic area. This larger area may consist of the county, Standard Metropolitan Statistical Area (SMSA), or even the state which contains the local school district and for which there are reliable population or enrollment forecasts available. This technique assumes that the relationship between school system enrollments and the population, or enrollment, of the larger area will remain constant, or that it will continue to change at the same rate as it has in the past. If this assumption appears to be acceptable, then the ratio technique may represent a useful forecasting tool.

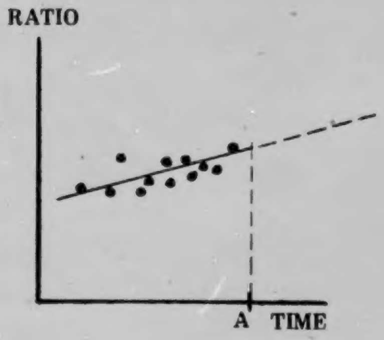
2.2.3.1 General Design

The ratio method initially involves the calculation of the historical 'ratio' between local school system enrollment and the population, or enrollment, of the larger area. A typical ratio would be computed as follows:

$$R_t = L_t \ / \ A_t$$

where R_t is the ratio in time period t, L_t is the enrollment level in the local school system in year t, and A_t is the population, or enrollment, of the larger area, also in the year t.

Based on historical values, this ratio may then be projected. If no trend is discernible, then the average of these past ratios may be used as the forecast value of this variable. If, however, some trend, either increasing or decreasing, is exhibited by the historical ratios, a method is included to extrapolate this trend using a regression technique against time. As in Figure 2-14, a linear or straight line is fitted to a series of ratios which have been computed from past data. This line is then simply extrapolated to obtain future ratios. It is assumed that the ratio is not expected to change drastically over the chosen planning horizon, and that the relationship between the school system and the larger area will remain relatively stable. The use of this extrapolation technique should be used only where the ratio changes gradually, and should be confined to a planning period which includes only those years in which the ratio does not become absurdly large or small.



"A" REPRESENTS THE CURRENT TIME PERIOD

FIGURE 2—14 EXTRAPOLATION OF HISTORICAL RATIOS

The forecast ratio is then applied to an available forecast of the larger area population in order to derive an enrollment for the local school district for any year during the planning period.

2.2.3.2 RATIO TECHNIQUE PROCEDURES

Prior to the execution of the actual procedures, an appropriate larger area and a suitable measure of trends within this larger area must be selected. If both historical data and acceptable enrollment forecasts are available for the larger area, this measure may be the most effective variable to use as a measure of trends in the larger area. Reliable forecasts of population are also acceptable measures and are usually more likely to be available. The principal criterion for the selection of a larger area will be the availability and reliability of forecasts. In general, the smallest area containing the local school district for which valid forecasts are available should be used. This generalization is based upon the assumption that conditions in a local school district are likely to be more reflective of conditions in a smaller area, such as the city or county (in which the school district is located), than of conditions in a larger area, such as the entire SMSA or the state.

Once the larger area has been specified along with the appropriate measure the following steps are used to derive local school district enrollment forecasts using Form H.

Step 1. Select an appropriate number of historical observations to include in the subsequent calculations. Five to ten years of historical data are recommended. If a significant discrete change in the ratio occurred in a particular year, as illustrated in Figure 2-15, the user may wish to consider using only those years after this unusual change took place. It would be useful, however, to investigate carefully the conditions that caused any discrete jump in the ratio in order to determine if such a change is likely to reoccur. The decision regarding the appropriate number of historical observations to use should be influenced by the previous trend exhibited by the ratio. For example, suppose that a graph of the ratio against time resembled that shown in Figure 2-16. If all the historical observations were used, the forecast trend would resemble Line A in this figure. This is obviously not an appropriate trend line since it shows a continually increasing value for the ratio, even though the most recent (and therefore the most relevant) history of this ratio would suggest a decline in future years. In this case, only the last several years of data should be used, thereby resulting in a projected trend which would resemble Line B in Figure 2-16, a more believable projection. In general the observed ratios should begin with the first year in which the trend expected in the future is suggested by the historical data.

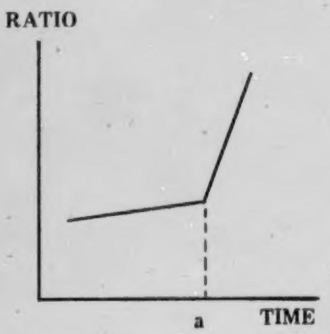


FIGURE 2–15 SAMPLE HISTORICAL RATIO DATA

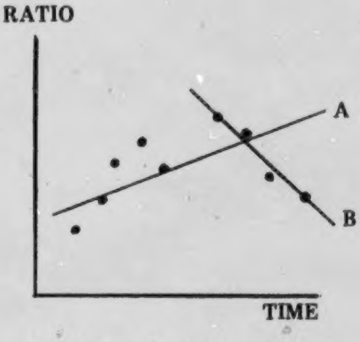


FIGURE 2–16 SAMPLE HISTORICAL RATIO DATA

The years included in the selected historical data set should be labeled on Line 1 (Form H), beginning with the earliest year and progressing consecutively to the current or most recent school year. The current year must appear in Column 10. Where less than nine years of historical observations are used, there will be columns on the far left-hand side of Form H which will remain blank. Two examples of the ratio technique have been prepared; the first illustrates the case where no trend in the historical values of the calculated ratio was evidenced so that the average of these past ratios was used as the projected future value. The second example demonstrates an extrapolation of the trend exhibited by past values of the ratio.

Step 2. On Line 2 number the years for which historical observations are used beginning with the first year.

Step 3. Enter on Line 3 the total enrollment of the local school district for each year identified in Line 1.

Step 4. Enter on Line 4 the population or enrollment of the selected larger area which contains the school district for each of the years considered.

Step 5. Divide each of the values on Line 3 by the corresponding values on Line 4. Enter the resulting values on Line 5. These values represent the historical values of the ratio between local school district enrollments and larger area population or enrollment.

Step 6. Compute the average of the values on Line 5. Enter this average on Line 6.

If there is no discernible trend evidenced by the historical ratios, then the average of these past ratios may be used as the estimated future value. If this is the case, omit Steps 7 through 14, and proceed directly to the instructions for Step 15 If, however, some trend is evidenced by the ratios on Line 5, the user should execute Steps 7 through 14.

Step 7. Compute the average of the values on Line 2 Enter this average in the space provided on Line 7.

Step 8. Subtract the value on Line 7 from each of the values on Line 2. Enter the resulting values on Line 8.

Step 9. Square each of the values on Line 8 and enter the results on Line 9.

Step 10. Sum the values on Line 9 and enter the total on Line 10.

Step 11 Multiply each of the values on Line 8 by the corresponding value on Line 5. Enter these products on Line 11.

Step 12. Sum the values on Line 11 and enter the total on Line 12.

Step 13. Divide the value on Line 12 by the value on Line 10. Enter the resulting value on Line 13.

Step 14. Multiply the value on Line 13 by the value on Line 7. Enter the resulting product on Line 14.

Step 15. Copy the values on Line 1 onto Line 15. Beginning in Column 11, label each of the years over the planning horizon. Line 15 will thus contain the years covering the historical data period as well as the years of the planning period.

Step 16. On line 16 consecutively number (beginning with one) each of the years which are shown on Line 15.

If no trend was identified from the historical ratios on Line 5, and Steps 7 through 14 were omitted, omit Steps 17 and 18 and proceed to the instructions for Step 19 If some trend was evidenced and Steps 7 through 14 were executed, continue to Step 17.

Step 17. Subtract the value on Line 14 from the value on Line 6. Enter the resulting value in each column of Line 17, ignoring those columns on the far right or the far left where no year is identified on Line 15.

Step 18. Multiply each of the values found on Line 16 by the value on Line 13. Enter the resulting products on Line 18. Proceed to the next step.

Step 19. If no trend was found to exist among the past values of the ratio on Line 5, the user should place the average value of the ratio on Line 6 in each column of Line 19 and proceed to the instruction for Step 20. If instead a trend appeared and Steps 7 through 14 as well as Steps 17 and 18 were executed, then the user should add each value on Line 18 to the corresponding value on Line 17. The resulting values should be entered on Line 19.

Step 20. On Line 20, beginning in Column 11, enter the forecast values for the population or enrollment level of the larger area used for each year over the planning period.

Step 21. To complete Line 21 through Column 10, multiply each value on Line 4 by the corresponding value on Line 19, entering the resulting values on Line 21. To complete the remainder of Line 21, i.e., from Column 11 on, multiply each value on Line 20 by the corresponding value on Line 19 and enter these resulting values in the appropriate column of Line 21.

The values now appearing on Line 21 will represent the estimated enrollment level for each of the years identified on Line 15. The values through Column 10 will give an indication of how closely the enrollment levels estimated using the ratio technique match the actual values on Line 3. The values in the remaining columns, Column 11 on, represent the forecast level of enrollment for each year over the planning horizon for the local school district.

2.2.4 Dwelling Unit Multiplier Technique

The dwelling unit multiplier technique may represent a useful alternative to the three previous forecasting techniques. It should be particularly applicable to rapidly growing school systems where a large portion of the increase in enrollment has been and is expected to be attributable to residential development. This technique requires more extensive data than do the other techniques and thus may not be feasible for some districts. The items for which historical data is required are the number of dwelling units by type of unit, if possible and the yield factor applicable to these dwelling units, i.e., the average number of public school children in each dwelling unit, by dwelling unit type if possible.

2.2.4.1 General Design

The technique may be applied for all dwellings grouped together, regardless of type, or for each specific category of dwelling units within the district. As fine a breakdown as possible should be used, with the deciding factor being the availability of data. In general, separate analysis of single and multiple family dwellings will be desirable, because the yield of public school children typically varies substantially between these two types.

Three basic procedures are involved in the estimation of future enrollment levels, using the dwelling unit multiplier technique. The first of these is the calculation of historical yields for each type of dwelling unit to be explicitly examined. Where data is already available for these yield factors, this initial procedure may be omitted. Where the past values of these yields are not known, a sampling procedure may be used to estimate them. This procedure requires that a random sample of the total enrollment be selected for each of the years included in the historical time span. The type of residence of each of the students in this sample is determined from any available files or, if necessary, observation in the field. Using the sample results, an estimate can then be made of the number of students who have resided in each housing type.

These yield factors must be forecast. If no trend is discernible from the historical values, then the average of these past yields may be used as the forecast value. If, however, either an increasing or decreasing trend is exhibited, a method is included to extrapolate this trend. Past yield factors may be regressed against time in order to forecast the yield for each type of dwelling unit. A description of this projection technique has been presented in Section 2.2.2. (See Curve Type A). The technique assumes that the yields will change in a slow and consistent manner during the planning period. If a more rapid or erratic change is expected, then another forecasting technique may be required.

The next step is to forecast the number of dwelling units of each type expected during each year of the planning period. A logistics curve is recommended. The characteristics of this curve have been presented in Section 2.2.2 (See Curve Types B and C). It assumes that a community's growth or decline will reflect an "S" curve: gradual initial growth (or decline), followed by accelerated change, which in turn tapers off at an upper (or lower) limit that can be estimated.

Once forecasts have been prepared of future housing levels, the expected yield factors are applied to produce estimates of future total enrollment levels for each year during the planning period.

2.2.4.2 DWELLING UNIT TECHNIQUE PROCEDURES

The procedures necessary to complete the dwelling unit multiplier technique may be performed by completing three forms. One copy of each should be used for each type of housing unit examined. The enrollment forecasts derived on each copy of Form K should be added together in order to obtain a total enrollment forecast for the entire school system.

Prior to the execution of the procedures, the user should select the appropriate dwelling unit types which are to be examined. This selection is unrestricted by the mechanics of the procedures themselves, but is highly dependent on the availability of data as well as the time and effort that the user wishes to devote to the collection of this data. In determining the extent to which specific dwelling unit categories should be identified, the characteristics of the existing and expected future housing stock must be carefully studied. If, for example, the vast majority of dwellings in the school district are single family units, and this is expected to remain the case over the planning horizon, then all housing units may be grouped into one type. If, on the other hand, multiple family units constitute a significant portion of the total housing stock, then several categories should be considered. The extent to which multiple family units are divided into categories, such as duplexes, garden apartments, and condominiums, should be a function of the degree of variance in the expected yields from each of these types. If the yields are similar and this condition is expected to continue to be the case over the planning horizon, then one category for multiple family units may be sufficient.

Part A: Determination of Past Yield Factors (Form I). The first task in the generation of enrollment forecasts using the dwelling unit multiplier method is to determine the historical yield factors for each dwelling unit type. Users who already have values for the past yield factor associated with each dwelling unit type being examined or who choose to employ some other method for determining these yields may omit this section and proceed directly to Part B. If the procedure presented here is to be used, one copy of Form I should be completed for each type of dwelling unit under study. The specific dwelling unit category must be identified at the top of each copy of Form I.

Step 1. Select the number of historical observations to be included in subsequent calculations. In general between five and ten years of historical data will be appropriate. The years chosen for inclusion in the historical data set should be labeled on Line 1 (Form I) beginning with the earliest year and progressing consecutively to the current or most recent school year. The current year must appear in Column 10. Where less than nine years of historical observation are used, the columns on the far left-hand side of the form will remain blank.

Step 2. Number the years on Line 2 for which historical observations will be used, beginning with one. The number found in Column 10 of Line 2 should thus represent the number of years of past data being considered.

Step 3. Enter on Line 3 the total enrollment of the local school district for each of the years identified in Line 1.

Step 4. Enter on Line 4 the number of dwelling units of the particular type being examined. This data may be difficult to obtain, especially in instances where the boundaries of the school system are not contiguous with other jurisdictions for which such data may be available. The planning division of the county or municipality which contains the school district may have the information or may be able to provide assistance in obtaining it. Census data may be used but is generally available only every ten years. One estimating method would involve determining from census data the initial number of units in the census year, and using housing permit data to estimate the number of additional units constructed or demolished in each subsequent year. If this method is used, it should be remembered that not all housing permits necessarily result in the construction (or demolition) of a dwelling unit. Furthermore, housing permits may lead actual construction and occupancy by a considerable length of time. Occupancy permits, utility company accounts, and even aerial photography may provide alternative information sources.

If only one type of dwelling unit is being examined, then Steps 5 through 8 may be omitted, and the user should proceed directly to the instructions for Line 9. If more than one type of dwelling unit is considered, however, then the user should proceed to the next step.

Step 5. To determine the yield from a particular type of dwelling unit, it is necessary to determine the number of students who reside in each type of dwelling. If this information is available by year, the number of students residing in the dwelling unit type being examined may be entered directly onto Line 8 and the user may proceed to Step 9. If, however, this data is not available, Lines 5 through 8 present a method for estimating such data. It is only one of many potential techniques which could be used. If an alternative method is preferred the user should again place the estimates so derived in the appropriate columns of Line 8 and proceed directly to Step 9.

historical observations to use may be influenced by the trend exhibited by past yields. For example, suppose that a graph of past yields over time appeared as in Figure 2-18. If all the historical observations were used, the forecast trend would resemble Line A in this figure. This would probably not be appropriate since Line A shows increasing yield factors even though more recent evidence would indicate a different trend. In such a situation, only data pertaining to the past several years should be used, thereby resulting in a more reasonable projected trend which would resemble Line B. It is therefore suggested that the observed ratios begin with the first year in which the expected future trend begins to be evidenced by the historical data.

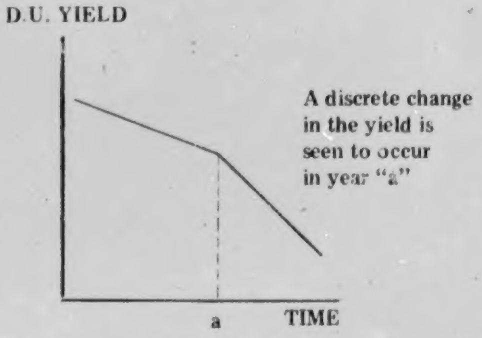


FIGURE 2–17 SAMPLE
DWELLING UNIT YIELD DATA

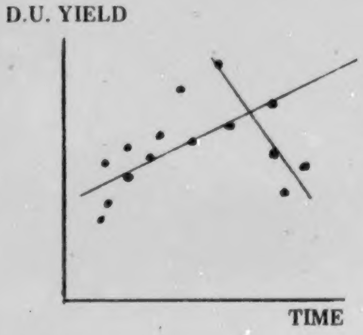


FIGURE 2–18 SAMPLE
DWELLING UNIT YIELD DATA

The years chosen for inclusion in the historical data set should be labeled on Line 1 of Form J, beginning with the earliest year and progressing consecutively to the current or most recent year, which should appear in Column 10.

Step 2. Number the years for which historical observations are used, beginning with the first year, on Line 2. The number found in Column 10 of Line 2 should thus represent the number of years of past data being used.

Step 3. Compute the average of the numbers on Line 2. Enter this average on Line 3.

Step 4. Subtract the value on Line 3 from each of the values on Line 2. Enter the resulting values on Line 4.

Step 5. Square each of the values on Line 4 and enter the resulting numbers on Line 5.

Step 6. Total the values on Line 5. Enter this total on Line 6.

Step 7. For each year identified on Line 1, enter the historic yield factor for the appropriate dwelling type on Line 7. These values may be found on Line 9 of Form I if the procedures outlined in Part A were conducted.

Step 8. Compute the average of the yield factors listed on Line 7. Enter this average on Line 8.

Step 9. Multiply each value on Line 7 by the corresponding value on Line 4. Enter these resulting products on Line 9.

Step 10. Total the values on Line 9. Enter this total on Line 10.

Step 11. Divide the value on Line 10 by the value on Line 6. Enter the result on Line 11.

Step 12. Multiply the value on Line 11 by the value on Line 3. Enter this product on Line 12.

Step 13. Copy the year information found on Line 1 on Line 13. Beginning in Column 11, label each of the years for the chosen planning period. Line 13 will thus contain the years covering the historical data period as well as the years up to the planning horizon.

Step 14. On Line 14 consecutively number, beginning with one, each of the years which are labeled on Line 13.

Step 15. Subtract the value on Line 12 from the value on Line 8. Enter the resulting value in each column of Line 15, ignoring those columns on the far right or the far left where no year is labeled on Line 13.

Step 16. Multiply each of the values on Line 14 by the value on Line 11. Enter the resulting products on Line 16.

Step 17. Add each value on Line 16 to the corresponding value on Line 15 and enter the resulting values on Line 17. These values will represent the estimated yield factor for each year labeled on Line 13. The values up to and including Column 10 will give an indication of how closely the fitted curve comes to approximating the actual past yields. The values in the remaining columns, Column 11 on, represent the forecast yield factor values for each year over the planning horizon for this type of dwelling. If for what ever reason the projected yield factors appear unreasonably small or large, the user is encouraged to modify them so that a more acceptable forecast is obtained.

Part C: Forecasts of Dwelling Units and Enrollments. Future yield values may be applied to dwelling unit forecasts in order to estimate enrollment levels. The first step is, therefore, to develop a forecast of dwellings. This task may be accomplished by executing Steps 1 through 24 on Form K. One copy of Form K should be completed for each dwelling type under consideration. The specific dwelling type should be labeled at the top of each copy of the form.

Users who have reliable dwelling unit forecasts available may omit Steps 1 through 23 and proceed to the instructions associated with Step 24.

Step 1. Select an appropriate number of historical observations to include in the subsequent calculations, in general between five and ten years of past dwelling unit data. The years included in the selected historical data set should be labeled on Line 1 of Form K, from left to right. The current year must appear in Column 10. Where fewer than nine years of past data are used, the columns on the far left-hand side of Form K will remain blank.

Step 2. On Line 2 number the years for which historical observations are used, beginning with the first year. The number in Column 10, Line 2, should thus represent the number of years of past data being used.

Step 3. Compute the average of the values on Line 2. Enter this average on Line 3.

Step 4. Subtract the value on Line 3 from each of the values on Line 2. Enter the resulting values on Line 4.

Step 5. Square each of the values on Line 4. Enter the resulting values on Line 5.

Step 6. Total the values on Line 5. Enter this total on Line 6.

Step 7. Enter on Line 7 the number of dwelling units of the type identified at the top of Form K for each year identified on Line 1.

Step 8. Specify the expected upper limit to the number of dwelling units of this type on Line 8. This upper limit represents the user's estimate of the maximum number of units of this type, regardless of whether this limit is reached during the chosen planning horizon or at some time period beyond this horizon. A simple method of estimating this upper limit is to determine the fraction of the total land zoned and likely to be developed for the particular type of dwelling unit that has already been developed, and then to divide the current number of dwelling units of this type by the fraction. This initial estimate of the upper limit assumes that future development will occur at existing densities. It should therefore be adjusted to expectations regarding future densities.

Because of the uncertainties associated with the specification of the upper limit, the user is encouraged to experiment with various assumed values. To do this, simply reiterate Steps 8 through 24, each time specifying a different potential upper limit. While laborious, such a process may provide valuable insight into alternative scenarios of growth.

Step 9. Divide each of the values on Line 7 by the value on Line 8. Enter the resulting values on Line 9.

Step 10. Subtract one (1.0) from each of the values on Line 9, entering the resulting values on Line 10.

Step 11. Determine the natural logarithm of each of the values on Line 10. Natural logarithms may be found in any handbook of mathematical tables. Enter these logarithms on Line 11.

Step 12. Compute the average of the values on Line 11. Enter this total on Line 12.

Step 13. Multiply each of the values on Line 11 by the corresponding values on Line 4. Enter the resulting products on Line 13.

Step 14. Sum the values on Line 13. Enter this total on Line 14.

Step 15. Divide the value on Line 14 by the value on Line 6. Enter this value on Line 15.

Step 16. Multiply the value on Line 15 by the value on Line 3. Enter the product on Line 16.

Step 17. Copy the numbers on Line 1 on Line 17. Beginning in Column 11, label each year over the planning horizon. Line 17 will then contain the years covering the historical data as well as the years of the planning period.

Step 18. Number consecutively on Line 18 beginning with one, each of the years identified on Line 17.

Step 19. Subtract the value on Line 16 from that on Line 12. Enter the resulting value in each column of Line 19.

Step 20. Multiply the value on Line 15 by each of the values on Line 18, and enter the resulting products on Line 20.

Step 21. Add each value on Line 20 to the corresponding value on Line 19. Enter the resulting values on Line 21.

Step 22. Determine the natural antilogarithm of each value on Line 21. Enter these antilogarithms on Line 22. Antilogarithmic values may be found in any handbook of mathematical tables.

Step 23. Add one (1.0) to each of the values on Line 22. Enter the resulting values on Line 23.

Step 24. Users who have chosen to use an independently derived forecast of dwelling units of the type being examined and have therefore omitted Steps 1 through 23, should first label each year of the planning horizon on Line 17, beginning in Column 11, and then enter on Line 24 the forecast dwelling unit values for each of the years thus identified.

If this is the case, the user should proceed to Step 25. If the logistic curve fitting method was used and hence Lines 1 through 23 were completed, the user should perform the following instructions.

Divide the value on Line 8 by each value on Line 23. Enter the resulting values on Line 24. These values represent the estimated number of dwelling units of this type in each of the years identified on Line 17. The values through Column 10 will give an indication of how closely the fitted curve comes to approximating the actual number of dwelling units on Line 7. The values in the remaining columns, Column 11 on, represent the forecast level of dwelling units of this type in each year over the planning horizon.

Step 25. Beginning in Column 11 of Line 25, enter the forecast yield factor for each year over the planning horizon. These forecast values have been independently derived or were generated through the completion of Form J (See Line 17).

Step 26. Multiply each value on Line 25, beginning in Column 11, by the corresponding value on Line 24. Enter the resulting products on Line 26. These values represent the forecast enrollment levels associated with housing of the type identified at the top of Form K for each year of the planning period.

2.2.5 Multiple Forecast Reconciliation

Four separate techniques have been presented to estimate future total school district enrollment. None of these techniques has been proven clearly to be superior. It is more likely that each may be an appropriate method under different sets of conditions. Whenever it is unclear which of the techniques is the most valid for a particular school district, it is both legitimate and potentially enlightening to use two or more techniques. The resulting divergence of forecasts derived from several techniques may in fact, provide more insight into future enrollment trends than the specific forecast values themselves. If, for example forecasts generated from the use of two different techniques were very similar, as illustrated in Figure 2-19, the user is more likely to have confidence in the forecast values. Each technique is based upon a slightly different set of assumptions. If both sets lead to the same conclusions regarding future enrollments, then each technique will tend to lend credence to the forecasts produced by the other. If, on the other hand, forecasts derived from two techniques are quite dissimilar, as shown in Figure 2-20, then the user should be alert to the possibility that some invalid assumptions may have been made. In such situations, a detailed review of the calculations associated with each technique should be made in an attempt to trace through the effect of various assumptions and perhaps identify the source of the discrepancy. Suppose, for example, that technique A in Figure 2-20 was the cohort survival technique, and technique B was the time trend projection technique employing a logistic growth curve, i.e., Type B curve. Technique B clearly shows a leveling off of the rate of growth in enrollments, while technique A demonstrates a constant rate of growth over the entire planning period. Two possible sources for this divergence are immediately apparent. Either the enrollment level is approaching a peak as residential development reaches a saturation point, and the cohort survival technique has not adequately accounted for this phenomenon, or the eventual maximum limit to enrollment growth has been underestimated in executing the logistic time trend projection. Re-evaluation of these possibilities may lead to useful insight into the sensitivity of enrollments to changes in these assumptions as well as the relative validity of the two sets of forecast values.

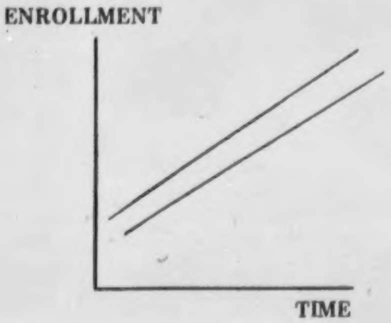


FIGURE 2—19 SIMILAR FORECAST RESULTS

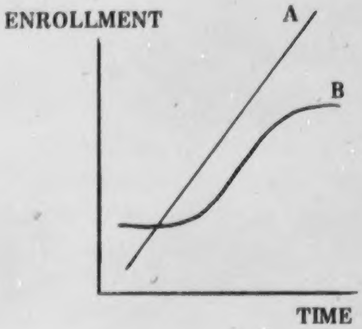


FIGURE 2—20 DISSIMILAR FORECAST RESULTS

In some cases where two or more techniques have been used and where the projections are reasonably similar, it may be desirable to produce one set of projections which summarizes the trend indicated by each of the techniques. When it is not possible to determine which of the forecasts is the most valid, an average of the forecast values might be used to serve as a crude synthesis of all the techniques used. If the average in each year of the forecast enrollments exhibited in Figure 2-19 was computed, it would appear as Line C in Figure 2-21. Such an average forecast might be useful in reducing confusion which could result from the presentation of two or more forecasts, and might conceivably represent the most valid forecast available. This averaging technique should be used only in cases where the forecasts derived from several techniques are quite similar and where there is no set of criteria upon which to evaluate the relative accuracy of the individual techniques.

In certain instances, the user may have more confidence in one technique for a certain number of years during the planning period, while placing more faith in the results of some other technique for the remainder. Suppose, for example, that the cohort survival technique appeared to be the most valid to use in the short run, e.g., one to five years, whereas the ratio technique appeared to be more valid for longer range forecasts, e.g. six to ten years. Further suppose that projections generated by these two techniques resembled line A and B in Figure 2-22, respectively. If the cohort survival forecasts were used for the first five years of the planning horizon and the ratio method was used for the next five years, a large discrete and unaccountable decline would appear in enrollments in the sixth year as seen in Figure 2-23. A method is therefore needed whereby the two forecasts can be linked together.

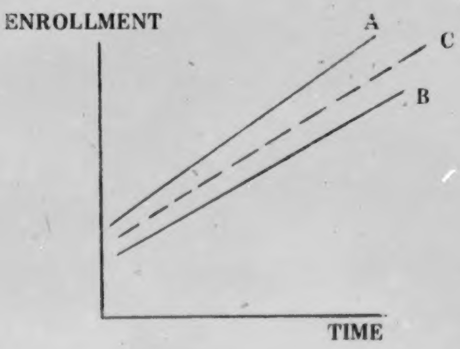


FIGURE 2—21 AVERAGE FORECAST VALUES

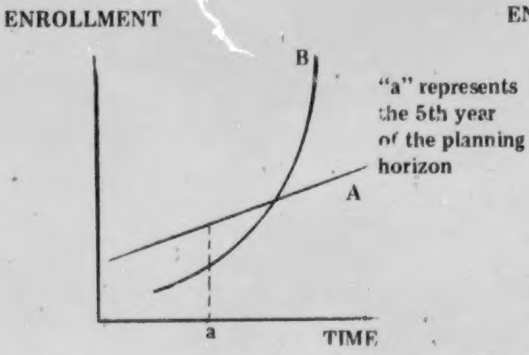


FIGURE 2—22 FORECASTS USING TWO TECHNIQUES

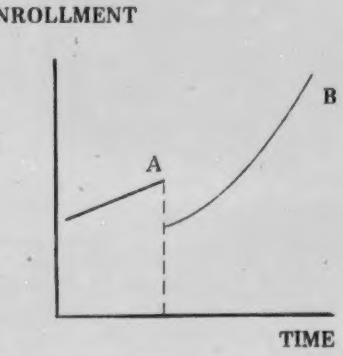


FIGURE 2—23 TWO UNRECONCILED FORECASTING TECHNIQUES

One method for reconciling two forecasts is as follows: First, the technique which is thought to be more valid for the short run should be used, beginning with the first year of the forecast period and continuing up to but not to include the year in which some other technique is believed more appropriate. In the above example, the cohort survival technique would be used to derive the enrollment forecasts for the first five years of the planning horizon. Next the technique believed to be more valid for the remaining years of the planning period should be initiated, using the forecast enrollment values which were generated with the first technique as historical data. For example, all of the forecast values shown on Line A in Figure 2-23 would be treated as historical observations and used in the ratio technique for forecasting the enrollments during the remaining years. The enrollment forecasts over the entire planning horizon might thus appear as in Figure 2-24.

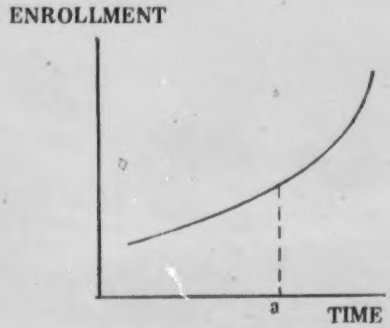


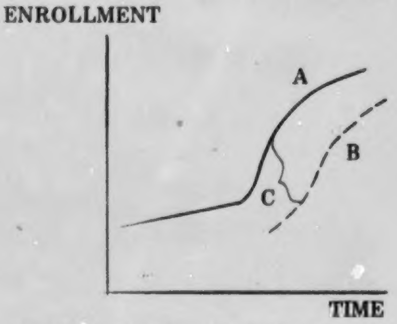
FIGURE 2—24 TWO RECONCILED FORECASTING TECHNIQUES

There should be no difficulties whenever the desired technique for the longer range forecast is the time trend projection method since the only required input data is previous enrollments, which will have been forecast by some other technique over the short range. When the cohort survival technique is preferred for the longer range projection, some difficulties will be encountered since the other techniques do not provide the enrollment forecasts for each grade. This data is required to calculate the survival rates. It will not be possible, therefore, to easily link several techniques when the cohort survival technique is used for the longer range forecasts. This situation is unlikely however, since the cohort survival technique is generally viewed as a short run forecasting tool.

A different problem develops when the dwelling unit multiplier method is used for making the longer range projections. Two essential elements are forecast in the process of executing this technique, future dwelling units and yields. While the dwelling unit projection will be unaffected by the short run forecasts derived with the use of some other technique, the yields associated with the various dwelling types may be altered. As no acceptable method for directly modifying these yields is available, the linkage must be handled in a different manner.

The steps of this alternative procedure require first using the technique thought to be appropriate in the short run up to, but not including, the year in which the dwelling unit multiplier technique becomes more valid. Then forecasts are generated using the dwelling unit multiplier method for each year of the planning period.

Next, subtract the enrollment forecast derived by using the dwelling unit multiplier technique, from the forecast derived by using the preferred short run technique for the last year in which the short run technique was used. The resulting value will act as an adjustment factor. Finally, beginning with the first year of the planning period for which the dwelling unit multiplier method is preferred, add the adjustment factor calculated in the previous step to the dwelling unit multiplier forecast in each of the remaining years of the planning horizon. The results of such an adjustment process might appear as Line A in Figure 2-25.



B REPRESENTS THE ORIGINAL DWELLING UNIT MULTIPLIER FORECAST,
C REPRESENTS THE ADJUSTMENT FACTOR.

FIGURE 2–25 ADJUSTED DWELLING UNIT MULTIPLIER FORECAST

Determining the precise year of the planning period in which the results of one technique become more valid or reliable than another is, of course, arbitrary. The process of linking the two techniques may, however be useful in avoiding confusion or concern which might arise from a discrete change in the forecasts from one year to the next, especially where the magnitude of the adjustment required is relatively small.

2.3 Enrollment Forecasts by Grade

Several procedures have been presented in Section 2.2 by which the total enrollment level for the school system may be projected. Total enrollment estimates should provide useful information about the general magnitude of future facility needs. The specific nature of these needs will, however, vary according to the distribution of the total enrollment among the different grades included in the school district. The objective of this section is to provide a methodology whereby enrollments may be determined for each grade level.

2.3.1 General Design

The recommended procedure is based on the assumption that the estimated total enrollment level for any particular year represents a more accurate and valid estimate than an estimate for any particular grade in the same year. All of the factors contributing to the uncertain nature of the total enrollment forecast will also be applicable to the forecasts for a particular grade. Additional factors might however, affect the enrollment within each grade more than the total enrollment forecast. For example, the retention rate for all grades taken together may remain very stable, even though the retention rates for various grades might fluctuate significantly. Therefore, the initial estimates for each grade generated by the following technique are adjusted so that their total equals the total enrollment forecast previously derived.

The method for deriving initial enrollment forecasts for each grade is the cohort survival or grade progression technique. As described in Section 2.2.1, it is based upon the calculation of a series of 'survival' rates from historical data. A survival rate indicates the fraction, either less than or greater than one, of students in a given grade and school year who 'survive' to the next grade in the next year. These estimated survival rates are then applied to current enrollments to generate estimates of the enrollment in subsequent years.

The estimates of enrollment for each grade are then adjusted according to the relative magnitude of the cohort survival total enrollment estimate and the estimate of total enrollment derived from some alternative procedure, the latter value acting as a control total. An adjustment factor is calculated for each year as follows:

$$a_t = E_t / S_t$$

where a_t is the adjustment factor for year t of the planning horizon, E_t is the total enrollment forecast serving as the control total, and S_t is the total enrollment forecast derived from the use of the cohort survival technique. The grade specific estimates generated using the cohort survival technique are then multiplied by this adjustment factor to derive the adjusted estimates.

Users who have generated the total enrollment forecast by employing the cohort survival technique will already have estimates for each grade and may therefore omit the procedures outlined below. If, however, the time trend projection (Section 2.2.2), the ratio method (Section 2.2.3), or the dwelling unit multiplier (Section 2.2.4) was used, or if some alternative method was used which did not encompass specific grade-by-grade estimates, the adjustment technique may prove useful in allocating total enrollments to the various grade levels.

This same method can be applied to the smaller geographic sub-regions or areas which are defined in Section 2.4. In this situation, the total enrollment forecast for the region or the area would act as the control total in adjusting the estimates for each grade. This would, of course, require historical data on enrollments in each grade level.

This method may similarly be applied to non-white enrollment forecasts, which are described in Section 2.5. Non-white enrollment estimates would be used as the control total in this case.

2.3.2 ENROLLMENT BY GRADE FORECASTING PROCEDURES

A set of guidelines is presented below for adjusting the cohort survival estimates of enrollments in each grade so that these estimates are consistent with the total enrollment forecast which has been generated.

Step 1. The first step in the allocation of total enrollment to various grades is to perform the cohort survival technique as described in Section 2.2.1.2 of this chapter. The calculations associated with the survival method should be carried out for each year of the planning period for which there are total enrollment forecasts. Upon completion of these steps the user will have estimates of future enrollments for each grade in each year over the planning period on Form D.

Step 2. Label the years of the planning period on Line 1 of Form L starting in the first column and continuing to the planning horizon.

Step 3. Enter on Line 2 of Form L, the total enrollment forecast which is to serve as the control total and to which the estimates of enrollments by grade are to be reconciled.

Step 4. For each year calculate the total future enrollments in all grades which have been estimated with the use of the cohort survival technique; i.e., sum the values in each column of Form D. Enter these totals on Line 3 of Form L.

Step 5. Divide each of the values on Line 2, by the corresponding values on Line 3. Enter the resulting values on Line 4. This is the adjustment factor.

Step 6. Identify on the extreme left-hand column of Line 5 through 17 the grades which are included in the school district. These same grades have been similarly identified on Form D.

Step 7. For each year of the planning period, multiply the value on Line 4 by each of the estimates of enrollments by grade on Form D. Enter the resulting products of this multiplication for each year on the appropriate lines of Form L.

The values on Lines 5 through 17 represent the adjusted estimates of projected enrollments by grade. The sum of these grade specific estimates for any given year should be equal to the total enrollment forecast on Line 2 of Form L.

2.4 Geographic Distribution of Enrollment

The preceding sections have been concerned with the task of forecasting enrollments on a district-wide basis. The geographic distribution of future enrollments will also be important for many school districts, especially where the location of schools to be closed or constructed is of interest. This section is provided to assist in projecting the distribution of enrollments. The projections for sub-geographic areas within the boundaries of the school district may then be reconciled with forecasts which have been made for the district as a whole.

Two levels of analysis are presented. A system for projecting enrollments for relatively large regions within the school system is described in Section 2.4.1. This geographic level of analysis may be particularly appropriate for school districts that encompass several regions, each readily distinguishable from another in terms of expected growth patterns, population densities, and other social or demographic characteristics. A second level of analysis is presented in Section 2.4.2 wherein the forecast enrollments for either the entire school system or for the larger regions are allocated to a number of smaller sub-geographic areas. The allocation process incorporated in this analysis is based primarily on the expected number of dwelling units in these small areas. The small area forecasts may be used as input data to the procedures in the Geographic Component (Chapter 5).

2.4.1 Regional Forecasts

Many school districts contain distinct regions which are characterized by differential rates of enrollment growth or decline. A school district may consist of a densely populated, highly developed urban region and a more sparsely populated suburban region in which future growth is likely. In such situations, a forecast generated for the school district as a whole would cover up differences that could be revealed through region-by-region analysis.

2.4.1.1 General Design

Sub-geographic area analysis may be especially important where one forecasting technique

2.4.1.2 REGIONAL FORECASTING PROCEDURES

The procedures for the generation of regional enrollment forecasts are presented very generally. The detailed steps associated with each specific forecasting technique have been set forth in Section 2.2 of this chapter. The following discussion therefore concentrates on interpreting the results of these procedures when applied on a regional rather than system-wide basis.

Step 1. The first step is to define several regions within the school system which are to be examined. The number of such regions should be kept reasonably small because of the amount of data collection and subsequent calculations involved, but more importantly because any single school district is unlikely to contain a large number of regions which are sufficiently different to warrant individual examination. Generally the school district should be separated into no more than four regions. This is, of course, an arbitrary specification; in many cases fewer regions will suffice, while in a few cases it is conceivable that more than four regions may be appropriate.

The basic principle to follow in dividing the district into regions is to define each region so that it includes the largest possible area about which generalizations can be made concerning current and expected enrollment patterns. Each region should contain a relatively homogeneous set of neighborhoods with respect to existing and expected population density and age distribution, zoning, racial composition, income level, and so on. If a school district was composed entirely of neighborhoods exhibiting similar characteristics, no division would be needed. If, on the other hand, one part of the school system was basically urban, fully developed, and composed of older families, while another geographic region was characterized by younger families and a large amount of undeveloped land, the need as well as the criteria for geographic division would be clear.

Specific data may be unavailable with which such homogeneous regions can be rigorously identified. In this case a comprehensive first-hand knowledge about the characteristics of individual neighborhoods within the school district is essential.

An additional consideration in the selection of regions within the school district should be noted. Since data for forecasting enrollments will need to be gathered on a regional basis, it may be practical to select boundaries which coincide with existing geographic divisions for which historical records have been maintained, such as school attendance or enumeration area boundaries.

Step 2. Once a set of regions has been identified, enrollment forecasts may be produced. The techniques presented in Section 2.2 may be used to accomplish this task. That technique which seems most appropriate for a particular region should be used with the exception that the data must pertain only to the region, rather than the complete district. The same or different techniques may be used for each region that has been identified. This decision should be based on the specific characteristics of the region as well as the availability of data.

Forecasts of future enrollments derived for each region should be entered on Form M. First label the years included in the chosen planning period on Line 1 of this form. Next, on the far left-hand side of Lines 2 through 5, identify the regions which have been examined. (If, for example, only two such regions have been examined, Lines 2 and 3 would be used and Lines 4 and 5 ignored.) Finally, the forecast of total enrollments in each region should be entered on the appropriate line for each year of the planning horizon.

Step 3. The final step is to examine the system-wide implications of the regional enrollment forecasts which have been generated. First, add the regional forecasts together to derive the total school system enrollment. The relevant values on Lines 3 through 5 of Form M should be totaled for each year of the planning period and entered in the corresponding columns of Line 6.

If a disaggregated approach for projecting total system-wide enrollments is thought to be appropriate, the values on Line 6 of Form M will represent the most valid estimates of future total district enrollments. In this case, no adjustment of the regional estimates is needed and the remaining lines of Form M may be omitted. If, however, the user has greater confidence in an independently calculated forecast of total school district enrollments, adjustments may be made to each regional forecast of enrollments so that their total is equal to the more acceptable system-wide forecast. In this situation, the user should enter the independently generated system-wide enrollment forecasts on Line 7. Next, each value on Line 7 should be divided by the corresponding value on Line 6. The resulting values should be entered in the appropriate columns of Line 8. These values will represent the annual adjustment factor which must be applied to each of the regional forecasts on Lines 2 through 5. The region names or identification codes should be re-entered to the left of Lines 9 through 12. Finally, for each year of the planning horizon, the adjustment factor on Line 8 should be multiplied by each of the regional forecasts on Lines 2 through 5, and the results entered on Lines 9 through 12. The values on Lines 9 through 12 will represent the adjusted forecasts for the enrollments of each region in each year of the planning period.

2.4.2 Small Area Forecasts

If a more refined level of geographic detail is desired the system-wide or regional enrollment forecasts may be allocated to a series of smaller geographic areas. The enrollments forecasts for these small areas could provide valuable insight into future geographic patterns of enrollment growth or decline. In addition, these forecasts will provide necessary information for the Geographic Component presented in Chapter 5, in which the issues of attendance area boundaries and site selection for either school closings or construction are addressed.

2.4.2.1 General Design

The method for estimating future enrollments in small areas is similar to the dwelling unit multiplier method as described in Section 2.2.4 of this chapter. A modified dwelling unit multiplier approach, in which the yield factors for each type of dwelling remain constant over time, is applied to the expected number of units of this type in order to derive an initial enrollment forecast for the area. The initial forecast for each area is then adjusted so that the enrollment total for all areas is consistent with the enrollment level previously forecast for the school district as a whole or for the region which contains the smaller areas. Growth which is attributable to residential development in a particular area is thus explicitly considered. Changes in all other variables affecting enrollments, such as the age distribution of the population or birth rates, are assumed to occur uniformly in each area within the region, or the entire school district where no breakdown into homogeneous regions has been undertaken.

A necessary input to this procedure is an estimate of future dwelling units in each area. For this reason, it is suggested that the previously described dwelling unit multiplier method be used in generating enrollment forecasts for the larger region or the school system as a whole where no regional breakdown is employed. As a necessary step in this procedure, dwelling units by type are projected. Such regional or system-wide estimates may be allocated to the small areas on the basis of available land in each area, and on sound professional judgement as to the outlook for future residential development in these individual areas. The mechanics of the procedure outlined below are independent of the method used in deriving the regional or system-wide forecasts.

2.4.2.2 SMALL AREA FORECASTING PROCEDURES

The procedures for allocating enrollment forecasts to small geographic areas are divided into seven major tasks: A) the division of the school district or region into smaller geographic areas, B) the selection of an appropriate number of dwelling unit types for consideration, C) the calculation of current yield factors in each area for each dwelling type used, D) the generation of dwelling unit forecasts by type, E) the generation of an initial set of enrollment estimates for each area, F) the adjustment of these estimates, and G) the determination of grade specific enrollments.

Part A: Area Definition. In Section 2.4.1, a technique is presented wherein the school district is divided into several geographic regions. Each of these regions should exhibit characteristics which distinguish it from other regions. Within an individual region, however, it is assumed that the neighborhoods are relatively similar. Where the school district has been divided into a number of regions, each region should be divided again into small areas or grids. Each region should consist of a discrete number of these smaller areas. In other words, no two regions can contain parts of the same smaller area.

The number of smaller areas or grids chosen is not constrained by the mechanics of the procedures. However, the greater the number of such areas, the greater will be the computational burden. In addition, as forecasts for smaller and smaller geographic areas are made, the validity of such forecasts will decline rapidly. As few areas as possible should be defined while still providing sufficiently detailed forecasts for use in the Geographic Component. Since the purpose of the Geographic Component is to allocate students to schools, the number of areas defined should be greater than the number of elementary schools. The exact number chosen will depend on the size of the district and the number of schools it contains. Thirty small areas are manageable with the technique and will usually suffice as a maximum. However if the school district is especially large or the number of elementary schools greater than ten, this suggested maximum may need to be exceeded to make the geographic analysis useful.

The shape of the defined areas or grids need not be uniform. Figures 2-26 and 2-27 provide examples of two of the many ways to delineate areas within a school district. An important consideration is the availability of data. Data necessary for forecasting enrollments for each area must be collected for that area. It may, therefore, be practical to select boundaries which coincide with geographic divisions for which historical information is available, such as census blocks or enumeration zones. An attempt should be made, where possible, to select areas which encompass approximately equal population levels. While equal-sized areas are desirable, if necessity dictates the collapse of several areas into one, those with lesser densities should be chosen.

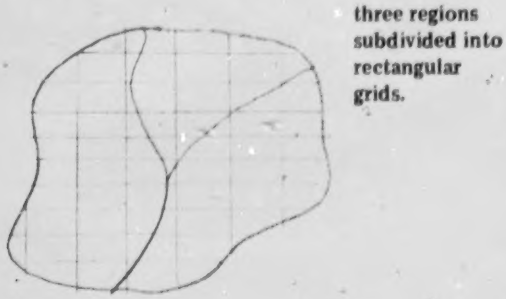


FIGURE 2—26 SAMPLE SCHOOL DISTRICT

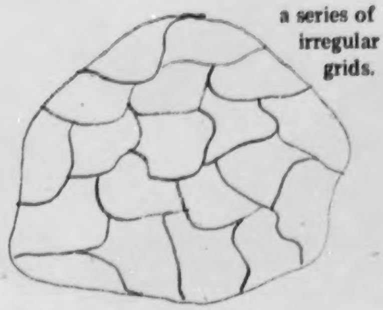


FIGURE 2—27 SAMPLE SCHOOL DISTRICT

Part B: Selection of Dwelling Unit Types. Different types of dwelling units are likely to exhibit different yields of public school enrollment. However, because of the increased number of computations associated with a very fine breakdown of dwelling types, it is suggested that a distribution be made only between single and multiple family units.

Part C: Current Yields. The next major task is to determine the current yield for each area. Form N is provided to assist the user in computing these factors.

Step 1. One copy of Form N must be completed for each dwelling unit type in each region that has been defined within the district. For example, if enrollment forecasts for three large regions have been estimated, and if two dwelling unit types are being considered, then six copies of Form N will be necessary. The region and the dwelling unit type should be identified at the top of Form N. Each row in Form N will apply to a specific area contained in the region. These rows should be labeled in order to identify the areas being examined.

Step 2. Enter in Column 1 of Form N the number of dwelling units of the type identified at the top of this form which currently exists in each of the areas under consideration.

Step 3. Enter in Column 2 of Form N the number of currently enrolled public school students who reside in the particular type of dwelling unit identified at the top of this form, for each area listed.

If the data required in Steps 2 and 3 is not readily accessible from existing school records, it may be possible to obtain this information from a survey of currently enrolled students. The address of each student will be known. If the type of dwelling is not easily determined from these addresses, the students could be asked to identify the type of residence in which they live. This survey would not need to cover the entire student body but could include only a random sampling from each area. Inferences about the number of students residing in a particular type of dwelling could be drawn from this sampling. Sandburn maps, aerial photos and/or municipal or county files may also be useful as sources for the housing inventory data.

Step 4. Divide each of the values in Column 2 by the corresponding values in Column 1. Enter the resulting values in Column 3. These values will represent the yield in the current year for dwelling units of the type identified at the top of the form in each area.

Part D: Dwelling Unit Forecasts. Next, a dwelling unit forecast by type must be generated for the school system or for the regions identified within the school system. The recommended procedure involves first the specification of an upper or lower limit to the number of units in the system or region. Previous dwelling unit data is used along with this limit to estimate a logistics curve. As reflected in Figure 2-28, the curve is then extrapolated in order to derive future dwelling unit forecasts. Using this technique, the user will be able to calculate estimates of the number of new units expected to be constructed in each year. The geographic distribution of these newly constructed units among the smaller areas must now be estimated. No specific procedure is presented for this allocation process. The allocation should be made on the basis of first-hand information and insight about the characteristics of each area. In the areas that are fully developed, little significant growth will be expected. Other areas may be unlikely candidates for growth because of zoning restrictions. In those areas which have land available for development, dialogue with local developers may provide useful information regarding the likely location and timing of future construction. When all available knowledge is exhausted, the user should allocate new construction which has not been previously accounted for in each year according to the amount of undeveloped but developable land remaining in each area.

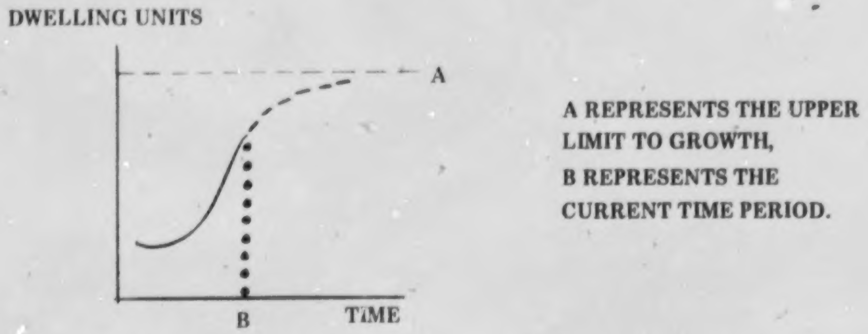


FIGURE 2—28 DWELLING UNIT FORECAST

Label each year of the planning period at the top of Columns 4 through 13 on Form N. For each year, enter the estimated number of dwelling units in Sub-column "a" on the appropriate lines. Repeat this process for each region and for each dwelling unit type.

Part E: Initial Enrollment Forecasts. Dwelling unit forecasts by type of unit for each area and for each year are now available in Sub-column "a." The current yield calculated in Part C may be applied to these dwelling unit forecasts to derive a set of initial enrollment forecasts. For each area, multiply the current yield found in Column 3 by each of the dwelling unit estimates found in Sub-column "a" of Columns 4 through 13. Enter the resulting values in Sub-column "b" for each year over the planning period. These values represent the estimated enrollments attributable to the type of dwelling identified by year in each area if the yield of public school students from each unit were to remain constant.

Part F: Adjusted Enrollment Forecasts. The initial forecasts of enrollments derived for each type of dwelling unit in Sub-column "b" are based on the assumption that the yield factor for each area will remain constant. In actuality, shifts in birth rates, age distribution, public versus private school preferences, and a variety of other factors will typically alter the yield. The approach recommended below assumes that the forecasts generated for the region or for the district as a whole will, in fact, incorporate such changes. The forecasts for each area should be adjusted to conform to the regional or district-wide forecasts so that the probable shifts in dwelling yield are reflected.

Step 1. Identify the years included in the planning horizon on Line 1 of Form O. This must be done for each region for which an individual enrollment forecast has been generated. Only one copy of Form O should be completed where no regional analysis was performed. Identification of these regions should be recorded at the top of Form O.

Step 2. Enter on Line 2 of Form O the estimated future enrollment in the region for each year of the planning horizon.

Step 3. Compute the total initial enrollments attributable to each dwelling unit type for each year. This may be accomplished by summing the values in Sub-column "b" in Form N. Enter these totals on the bottom line of Form N. These values represent the expected number of students enrolled in the region who reside in the particular dwelling unit type identified at the top of the form.

Step 4. For each region and for each year of the planning period, total the enrollments on the bottom line for each Form N completed for the region. Enter these totals in the appropriate columns on Line 3 of Form O.

Step 5. Divide each of the values on Line 2 by the corresponding value on Line 3 of Form O. Enter the resulting values on Line 4. These values indicate the adjustment factors applicable to each area within the region.

Step 6. Multiply the adjustment factor on Line 4 of Form O by the initial enrollment estimates for areas within the region in Sub-column "b" of Form N. Enter the resulting products in Sub-column "c" of Form N. Repeat the process for each year of the planning horizon. These values will represent the adjusted estimates of enrollment by dwelling type.

Step 7. One copy of Form P should be completed for each region for which enrollment estimates have been derived. Identify the region at the top of the form. Also identify in the far left column each of the smaller areas contained in the region. Above each column in Form P, label the years included in the planning period.

For each area in each year, add together the enrollments attributable to the various dwelling unit types that have been recorded on Form N. Enter these totals in the appropriate spaces of Form P. These values represent the total enrollment estimates for each area in each year covered by the planning horizon. The sum of these area estimates for a given year should equal the regional estimate for that year.

Part G: Grade Specific Forecasts. The Geographic Component will typically be used to analyze the attendance boundaries or site selection of schools for elementary, middle, or high school students. In many cases, it will thus be necessary to disaggregate the area forecasts to specific grade combinations. The recommended procedure is to determine the percentage of total students expected to be in the particular grades of interest at the regional or district-wide level, for each year in the future. These factors are then multiplied times the total enrollment forecasts for all areas within the region. The regional or district-wide factors may be calculated by performing the cohort survival technique, adding together the grade totals that make up a particular grade organization, and then dividing that sum by the total student body. The resulting fraction will indicate the percent of all students in a given combination of grades for a particular year.

2.5 Racial Composition

The expected racial composition of future enrollments may be of interest to many school systems in terms of educational needs and racial balance among schools. No unique technique has been designed to forecast non-white enrollments in this chapter. Rather, the suggested approach is to repeat previously described procedures in each case replacing all data pertaining to enrollments with data for non-white enrollments only. The following brief discussion is intended to provide some guidance in the use of the various techniques.

2.5.1 Cohort Survival Technique

The cohort survival technique may be used to forecast future non-white enrollment levels by substituting non-white enrollment by grade whenever enrollment data is needed in the procedures described in Section 2.2.1. If possible, birth data by race should be used in the derivation of initial grade enrollments.

In instances where the racial composition of enrollments is changing very rapidly, the cohort survival rates are apt to vary considerably from one (1.0). These rates may also exhibit a large degree of fluctuation over time as the racial composition changes. This possibility renders the cohort survival technique less appropriate since the method itself assumes stable rates of change. Extreme caution should be used when employing this method.

2.5.2 Time Trend Projections

The procedures described in Section 2.2.2 for extrapolating past trends may be an appropriate technique to use in projecting non-white enrollment levels. The only required data is historical non-white enrollment information. Again, if a dramatic change has been occurring in racial composition, the use of this technique will involve a high degree of uncertainty, especially if a Type A, linear or straight line curve is used to represent future trends. A nonlinear pattern is more likely to yield acceptable results. In specifying the upper or lower limit for the non-white enrollment level, the user should examine the limit which was specified for total enrollments. An estimate of the percent of this eventual total enrollment limit thought to be non-white could then be used to derive the limiting value to apply when forecasting non-white enrollments. It should be cautioned, however, that in some districts while total enrollments may be decreasing, non-white enrollment may be on the rise. Extreme care should be exercised when selecting an appropriate curve.

2.5.3 Ratio Method

The ratio method may also be used to forecast non-white enrollments. The enrollment data used should pertain to non-white students only. A stronger relationship might be expected to exist between non-white enrollments in the local school system and the level of non-white population or enrollment for the county, SMSA, or state, than between local non-white enrollment and total population or enrollment for the larger area. If forecasts of non-white population or enrollments are available for the larger area, they should be used as the appropriate measure of future areawide trends.

2.5.4 Dwelling Unit Multiplier Technique

When this technique is used to forecast non-white enrollments, non-white student yields should replace total enrollment yields. The dwelling unit inventory and subsequent forecasts of this variable would be similar to that used in the generation of forecasts of total enrollment levels.

If the racial composition in the school system has been changing rapidly, caution should be used in the extrapolation of yield factors for non-white enrollments. If these yields have increased or decreased significantly in the past, then an extrapolation of this trend may result in unrealistically high or low forecast values.

2.5.5 Enrollment Forecasts by Grade

Forecasts of non-white enrollments in each grade may be generated in exactly the same manner as that presented earlier. The enrollment data would, however, encompass only non-white students.

2.5.6 Geographic Distribution of Non-white Enrollments

Perhaps the most important planning aspect of future non-white enrollments is their geographic distribution. This may be estimated by following the procedures exactly as presented in Section 2.4 of this chapter, using non-white rather than total enrollment data. The region or area boundary definitions should be identical to those used in predicting the distribution of total enrollments. The total enrollment estimates for each region or area may be used as a check on the validity of similar estimates generated for non-white students.

In summary it is quite possible to use the procedures described in previous sections of this chapter to derive forecasts of non-white enrollments, thereby drawing inferences regarding the likely racial composition of students in the school system. Caution should be used because the variance in non-white enrollments may be greater than that of total enrollments, thus adding to the degree of uncertainty associated with these forecasts.

2.6 Uncertainty

In the preceding sections, techniques have been presented for projecting total enrollment levels, enrollments in each grade, and the geographic distribution and racial composition of future public school students. Each of these projections will be characterized by uncertainty, the nature and extent of which will vary from one technique to the next, and from one school district to another. The objective of this section is to examine approaches for considering this uncertainty. The concept of confidence intervals introduced in Chapter 1 is further examined as a means for measuring the uncertainty associated with a particular enrollment forecast. Beyond this a set of factors is identified which might cause actual enrollment levels to diverge from forecast levels. Procedures for adjusting the forecast values in light of expectations regarding these specific factors are suggested as a means of reducing uncertainty.

2.6.1 The Measurement of Uncertainty

Confidence intervals or bands may be used to measure the uncertainty associated with a particular enrollment forecast. A confidence interval shows the range of values which might be expected to occur for a specified confidence level. Suppose, for example, that the confidence interval illustrated in Figure 2-29, was estimated for a confidence level of 0.95. The user would be ninety-five percent certain that the enrollments in each year would fall within the range bracketed by the upper and lower limits shown as Lines A and B respectively.

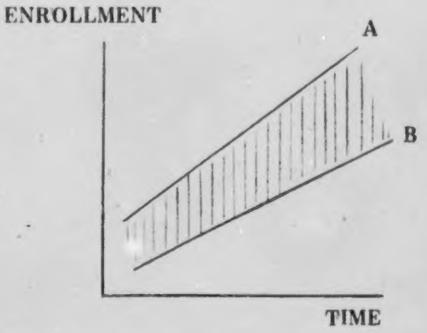


FIGURE 2- 29 SAMPLE CONFIDENCE INTERVAL

Reliable estimates of such confidence intervals might be used to assist the user in the decision-making process. For example, suppose that the estimated enrollments in each year of the planning period appeared as Line A in Figure 2-30 and that the student capacity was represented by Line B. This figure indicates that enrollments would be expected to exceed capacity in the sixth year of the planning period. However, because of the uncertainty involved in the forecast, this shortage of space might well be encountered at an earlier or later date. A confidence interval may be estimated for this forecast, as illustrated in Figure 2-31. This interval would indicate that there was a possibility within a ninety-five percent confidence level, that this shortage could occur as early as the fourth year of the planning period, and the user could be more than ninety-five percent sure that the shortage would exist by at least the ninth year of the planning period. The sixth year would still represent the most probable estimate of the shortage; however, the introduction of confidence intervals would provide added insight into the flexibility which might be desirable in the future facility plan and into the risks associated with various alternatives.

As noted in Chapter 1, several distinct approaches could be used in estimating confidence intervals for enrollment forecasts. The statistical approach would involve estimating confidence intervals based on variation in the historical data used to derive the forecast itself. The calculations using this approach would, in most cases, be both complex and laborious, and the potential additional insight gained would probably not be sufficient to offset the additional required effort. A more fundamental objection stems from the fact that these confidence intervals would be based almost entirely on historical data and would not facilitate the incorporation of expected future conditions in the school system. For these reasons, specific procedures are not presented for the calculation of confidence intervals using this approach.

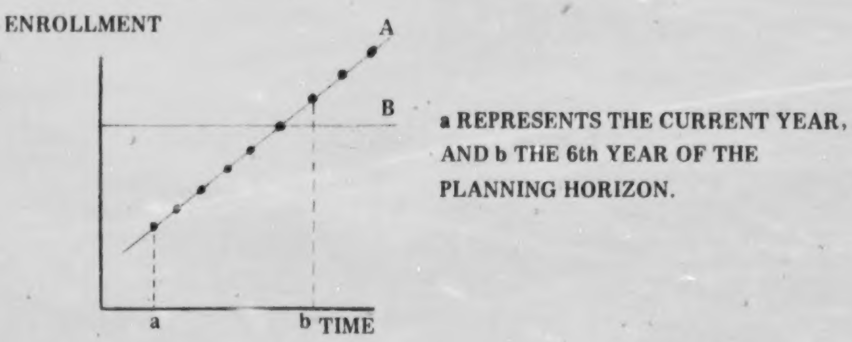


FIGURE 2—30 ENROLLMENT FORECAST AND SCHOOL CAPACITY

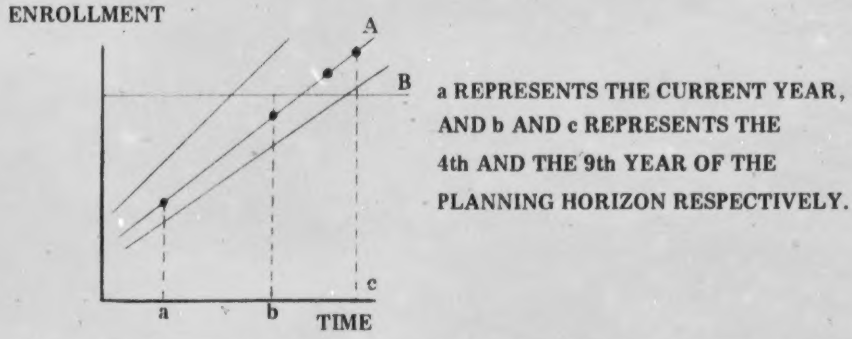


FIGURE 2—31 ENROLLMENT FORECAST WITH CONFIDENCE INTERVAL

The alternative subjective approach tnat is recommended is based upon user specified potential high and low values for certain inputs to the basic forecasting techniques already described. These procedures are repeated using first the high estimates and then the low estimates. The resulting forecasts represent the likely upper and lower limits for future enrollment trends. While statistically less rigorous, this approach may have more intuitive appeal and is likely to make better use of first-hand knowledge concerning the unique characteristics of the school district.

The most difficult aspect of this subjective approach is the specification of high and low values for the various inputs. For this reason several values for high and low specifications may be used to determine a series of confidence intervals. While the validity of the high and low estimates will be difficult to test, the assumptions upon which subsequent forecasts are based will be available for scrutiny. The impact on the confidence band resulting from changes to these high and low specifications will itself be of interest. If the impact of two different sets of likely high and low values can be shown to be very slight, for example, then the need for extensive debate concerning the precise specification of high and low values will have been eliminated.

The estimation of confidence intervals using the subjective approach for each of the enrollment forecasting techniques outlined in Section 2.2 is briefly described below.

2.6.1.1 Cohort Survival Technique

This technique involves the computation of a series of survival rates using past enrollment data. These past rates are averaged or extrapolated and applied to current enrollments to derive forecasts of future enrollment levels for each grade. The initial grade enrollment is estimated on the basis of births five or six years previously. The projected grade-survival rates and the projected birth-survival rates may, of course, over-or under-estimate the actual rates which will prevail during the planning period. On the basis of variations in the previous values for these rates and the user's perception of future trends, a high and low value for each may be specified. For example, if the average survival rate for students progressing from the sixth to the seventh grade was equal to 1.05, the most probable forecast would be derived using this value. If the user believed that each of the survival rates could conceivably be ten percent higher or lower, the high and low survival rates would be specified as 1.155 (i.e., 1.05 x 1.10) and .945 (i.e., 1.05 x 0.90) respectively. These values would represent the user's best perception as to the reasonable maximum and minimum values which the survival rates could take. In other words, it would be thought quite unlikely that future values for this survival rate would be greater than 1.155 or less than 0.945.

The procedures of the cohort survival technique should be repeated twice, using first likely maximum survival rates and then likely minimum survival rates. The resulting two additional sets of forecasts will represent a confidence band for future enrollments as illustrated in Figure 2-32.

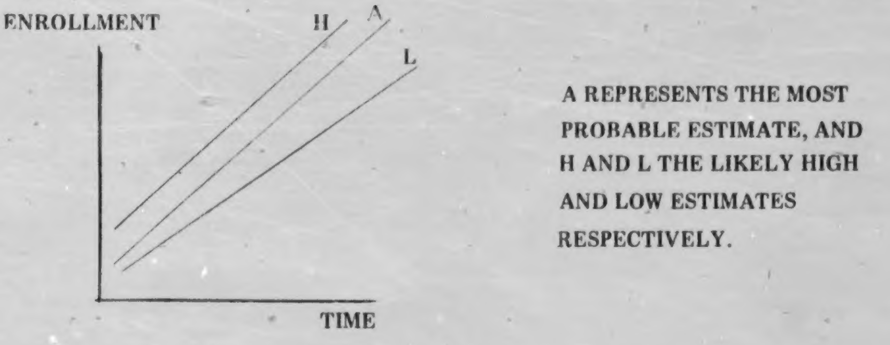


FIGURE 2—32 CONFIDENCE INTERVALS—COHORT SURVIVAL

2.6.1.2 **Time Trend Projections**

Confidence intervals for Type B curves may be derived by specifying high and low estimates of the eventual maximum enrollment level (Line 8, Form F). The procedures described for extrapolating this curve would then be performed using first the high and then the likely low values for this maximum. The resulting sets of forecasts would represent the limits for the confidence band for future enrollments. A typical confidence band thus derived is illustrated in Figure 2-33.

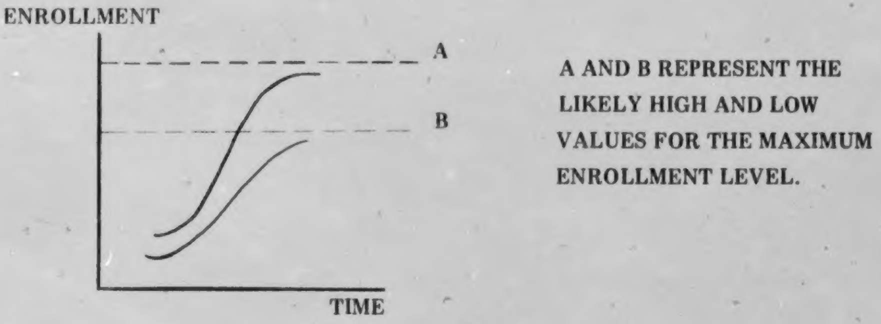


FIGURE 2—33 CONFIDENCE INTERVALS—LOGISTICS GROWTH CURVE

Confidence intervals for Type C curves may be similarly determined by specifying the eventual minimum enrollment level (Line 8, Form G) first with a high and then with a likely low estimate as illustrated in Figure 2-34.

These likely high and low values may be estimated by making different assumptions regarding future densities, zoning patterns, birth rates, and other factors influencing development. An analogous procedure is not available for Type A curves.

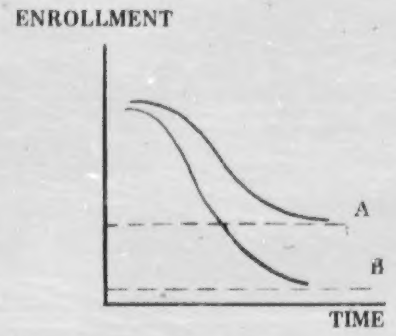


FIGURE 2–34 CONFIDENCE INTERVALS–LOGISTICS DECLINE CURVE

2.6.1.3 Ratio Method

Confidence intervals may be derived for enrollment estimates using the ratio method by making assumptions about the potential high and low value for the larger area population or enrollment forecasts, and/or the ratio itself. High and low estimates for the larger area may already be available. If not, the user is encouraged to experiment with several sets of such values that seem reasonable. Initial high and low specifications for the ratio will be more difficult to determine since this ratio is not linked to any single measure of local or regional conditions. The procedures of the ratio method may be reiterated using these high and low estimates for future large area forecasts and for the ratios. The resulting forecasts will represent the limits of the confidence band.

2.6.1.4 Dwelling Unit Multiplier Technique

Confidence intervals for enrollment estimates using the dwelling unit multiplier method may be generated by specifying high and low assumed values for the eventual maximum number of dwelling units as well as the projected student yields. The high and low estimates for the number of dwellings of each type may be obtained by considering the impact of alternative local economic conditions, and local government development policies. Likely maximum and minimum values for the yield factors may be estimated by using different assumptions about the future age distribution of the population and/or birth rates. The set of high estimates can be used to derive the upper boundary of the confidence band, and the set of low estimates used to generate the lower limit by reiterating the forecasting procedures.

The most difficult task in the estimation of confidence intervals using this approach will be specifying realistic and appropriate high and low values. All available previous data should be carefully examined. In addition, assistance might be sought from sources such as a local or regional department of planning or bureau of vital statistics.

The validity of these confidence intervals will be dependent upon the quality of the high and low values used. The use of a subjective approach in determining these values presents an opportunity for the integration of sound professional judgement with explicit statistical forecasting procedures.

2.6.2 Forecast Adjustments

It may be possible to further reduce forecasting uncertainty by examining several contingent trends in factors not explicitly dealt with in the projection techniques. Each of the previously discussed enrollment forecasting techniques is based upon a specific set of assumptions. The procedures themselves merely translate past data into forecast values on the basis of these assumptions. Certain events which may not be accounted for in the mechanics of the forecasting technique will significantly impact future enrollment patterns. A list of such phenomena is presented below. This list should be carefully examined to determine which, if any, of the potential situations might be of importance in the particular school district. In those instances where the events have not been adequately incorporated into the technique used to derive the initial enrollment forecasts, an adjustment should be made. For example, suppose that a relatively large trailer court was expected to be developed at some point in the future. If no significant trailer court development activity had occurred in the past, then none of the forecasting techniques would be expected to pick up the discrete increase in enrollments which might result. The number of additional public school students attributable to this future complex should, therefore, be independently estimated. The previously developed enrollment forecast would then be adjusted by adding the estimated trailer court enrollments to it.

This adjustment process may be performed at any level of detail as long as it is possible to identify the additional students by geographic location, age, race, or any combination thereof.

It should be emphasized that enrollment adjustments for a particular phenomenon or unique event should be made only if it was clearly not considered by the previously used forecasting technique. Careful thought must be given to precisely which phenomena have and have not been addressed. If the user believes that the future trend in one or more of the factors considered in the original forecasting technique will significantly differ from the historical trend, an adjustment to the initial forecast may be appropriate. For example, suppose that the trend in public versus private school preferences among families residing within the district resembled that curve shown in Figure 2-35.

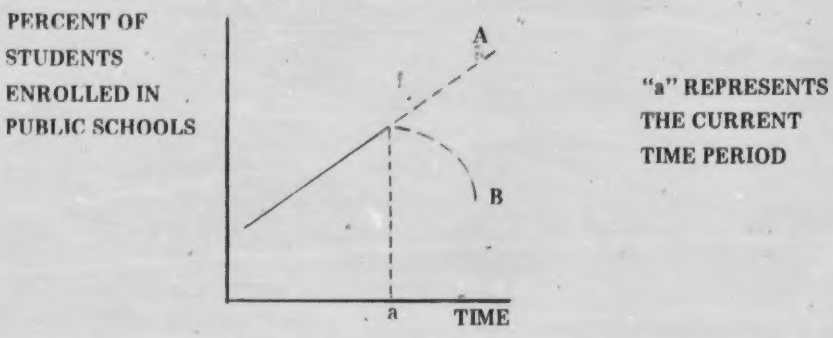


FIGURE 2—35 ADJUSTMENTS DUE TO CHANGE IN TRENDS

If this trend were expected to continue as illustrated by dotted Line A, then explicit consideration need not be given to this factor as its effect on public school enrollments would be implicitly incorporated into each of the forecasting techniques. If, on the other hand, this trend were expected to shift dramatically so that the pattern resembled dotted Line B, an adjustment would be necessary. Thus, whenever an abrupt change in the trend of any factor influencing public school enrollments is expected, the magnitude of this change should be evaluated and an adjustment to the basic forecast considered.

A second type of potential change that might not be incorporated into the forecasting techniques would be a unique, discrete alteration in some factor influencing public school enrollments. For example, suppose that the past trend exhibited in public versus private school preferences appeared as in Figure 2-36. Again, if the trend was expected to continue relatively unaltered, as shown by dotted Line A, no adjustment would be necessary. If, however, the user, possibly through personal contact with local private school officials,

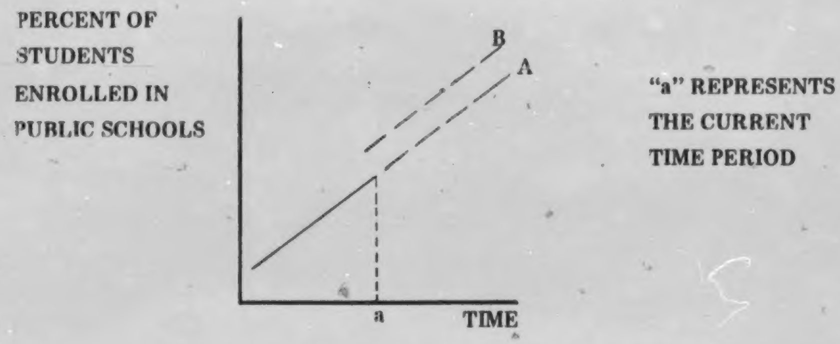


FIGURE 2—36 ADJUSTMENTS DUE TO UNIQUE EVENTS

expected a major discrete change in this preference, then the future pattern might appear as Line B. This phenomenon could occur as the result of the closing of one or more private or parochial schools. An adjustment to the public school enrollment forecasts would then be called for in each year of the planning period, beginning with the year in which the discrete change was expected.

The following list briefly describes some of the changes which may warrant forecast adjustments. Additional considerations are presented in Chapter 7.

Public versus private school preferences. A change in private school demand may be brought about by a shift in the religious composition of the population, or may result from a change in the availability of nearby private or parochial schools. A review of private school trends should focus on the entire region, as private and parochial school trends in surrounding school districts may impact the local public school system enrollments. Particular attention should be devoted to the possibility of major private school closings or openings.

Residential development. An adjustment might be appropriate if a very large subdivison or apartment complex was scheduled for construction or demolition at some point over the planning period. Similarly, a significant change in the number of families residing in trailers or mobile homes could also rapidly alter future public school enrollments. In all cases these proposed complexes should represent a distinct departure from existing trends. Where the proposed development appeared to be a continuation of existing patterns, it might well already be accounted for in the basic forecasting technique.

Birth trends. The abrupt alteration of birth rates which occurred in the 1960's significantly affected enrollments in many school districts. Birth rate forecasts should be reviewed at the national, state, or local level to examine recent and expected local birth trends.

Migration trends. Fundamental causes of inter- and intra-regional migration should be reviewed in an effort to detect the possibility of a distinct shift in migration trends. An abrupt change in the regional economy could influence migration into or out of the metropolitan area. A major road, utility extention or commercial development could influence migration from one school district to another within a metropolitan area. Indications regarding the likelihood of a disruption in historical migration patterns may necessitate an enrollment adjustment.

Age distribution. The age distribution of families residing within the boundaries of the local public school system will significantly affect enrollment levels. In many neighborhoods, families tend to remain at the same residence after their children have gone through the school system. As these families reach retirement age they are more likely to leave the district, vacating homes which may be reoccupied by younger families with school age children. In cases such as new suburban communities where a large number of persons moved into the district during the same time period, many are also likely to move out at roughly the same time. A dramatic and rapid change in the average age of the school district's population and hence enrollments could occur. Where this 'cycling' effect is expected, an adjustment of future enrollment estimates may be necessary. A careful examination of any available data reflecting the age of residents within the school system will assist in identifying the potential for such rapid neighborhood turn-over, and the likely magnitude of its consequences.

Annexation/Mergers. The annexation of additional land by the school system will, of course, affect future enrollment. Since this one-time event would not be included in any historical data, its potential effect on enrollments must be independently estimated and added to the basic forecasts which have been derived. Also, when several school systems are combined into one, enrollment forecasts for each of the school systems would need to be calculated separately, and then added together.

Institutional changes. A major change in the disposition of a military base or other federal installation may occur very suddenly, often with significant impact on the surrounding community. The closing or opening of a major industrial plant, university or other large scale employment center would have a similar effect. Knowledge of this kind of major community impact will necessitate adjusting the enrollment forecasts.

The above list is not inclusive, but is intended to suggest the types of phenomena which should be considered, and if relevant, adjusted for in the enrollment forecasts. Where it is believed probable that a major shift in trends or a unique event has not been accounted for by the forecasting technique, the user should attempt to estimate the magnitude of shifts and adjust the initial forecast accordingly. If used with discretion, this adjustment, should increase the validity of the enrollment forecasts. Blind adherence to a set of forecast values simply because they have been statistically derived, should be avoided. An initial forecast developed with any of the above techniques should be viewed as a base line from which to deviate when warranted by the user's judgement and knowledge of the school district. The accuracy and validity of the enrollment forecasting techniques will, in the final analysis, depend largely on the skill and diligence with which they are applied.

Chapter 3: Facility Component

The objective of the Facility Component is to examine the impact of expected enrollment levels on future facility needs. These expected facility requirements may then be compared to the school district's existing facilities so that any shortage or surplus of educational space can be identified.

3.1 Overview

The Facility Component serves as the link between future enrollment forecasts and the development of capital planning strategies. It requires that enrollment forecasts be available, whether generated by the previous component or independently derived. The procedures will assist in translating enrollment forecasts into the estimated number of teaching stations or amount of square footage, or both, necessary to accommodate them. Comparison of the projected space requirements with existing or planned school buildings will indicate the dimensions of the planning problem.

With this information the user may formulate alternative strategies for resolving any serious excess or deficit space situations. Guidance for developing such strategies is presented in Chapter 7, "Planning Considerations." Once identified, a strategy may be "tested" by entering the proposed standards, policies, and/or structural modifications into the appropriate parts of the System and examining the facility, fiscal, and geographic implications.

The required teaching stations or square footage implied by a given enrollment forecast will be dependent upon the educational programs and policies unique to each school district. This is recognized in the System by requiring that the user specify several critical standards and policies which may impact future facility demand. Additional flexibility is provided that allows the analysis to be conducted on a district-wide, on an individual school, or on a subject area or educational space basis, depending on the needs of the school district. Thus, for example, some districts will be satisfied to examine the overall excess or deficit of space, while others will want to examine probable conditions for a particular school or for special kinds of space.

The user is encouraged to repeat the analysis in order to examine the impact of modified standards or policies. Similarly the effect of alternative enrollment forecasts might be considered. By using several enrollment forecasts, the user will better understand the extent to which future facility needs may be dependent upon unpredictable variables in the community itself.

The next section of this chapter briefly outlines the technique used in the translation of enrollment forecasts into facility needs and examines the assumptions underlying this technique. The third section presents the step-by-step procedures necessary to carry out the basic calculations. A final section is included to assist in analyzing and interpreting the technique itself along with the resulting output. An example is included to illustrate the necessary steps.

3.2 General Design

The technique employed in this component requires the conversion of expected student enrollments into a measure of the effective impact of this enrollment. This measure is expressed in terms of the average number of students which must be accommodated at any given time during a typical school week. The concept becomes especially important where the analysis is to be conducted on a subject area level of detail. This "effective enrollment" level is then translated into a measure of concomitant facility needs. The translation may be done in terms of the number of teaching stations which will be needed, or the amount of square footage which will be required, or both. Finally, the chosen measure(s) of facility needs is compared to the corresponding measure(s) of existing facilities in order to identify the nature and magnitude of any potential future shortage or surplus of educational space.

3.2.1 Calculating "Effective Enrollment"

The technique used to translate the absolute number of enrolled students into the number of students which must be accommodated at any given time, i.e., the level of "effective enrollment," may be summarized by the following mathematical expression:

$$(1) \qquad E_{ij} = \left\{ N_i \left(\frac{A_{ij} \quad W_{ij}}{P_{ij} \quad D_{ij}} \right) \right\} \Big/ U_{ij}$$

The variables used in this expression are defined as follows:

E_{ij} : the 'effective enrollment' level (i.e., the number of students expected to be physically in attendance at any given time during a typical school week)

N_i : the number of students enrolled

A_{ij} : the average number of courses taken by each of the N students

W_{ij} : the average number of periods per course each student attends in a typical school week

P_{ij} : the number of periods per day in which classes are held

D_{ij} : the number of days per week in which classes are held

U_{ij} : the desired maximum utilization rate (i.e., the average percent of educational space which is occupied at any given time over a typical school day)

The subscripts i and j associated with the variables refer to the school and subject area (or educational space type) being examined respectively. For example, E_{ij} may be read as the effective enrollment in school i in subject area j.

As noted, the level of analysis should be varied depending upon the needs of each school district. The task of estimating future effective enrollments may, therefore, be performed for any of several levels of detail. The user who wishes to examine each school individually should simply interpret each of the variables in equation 1 as applying to a particular school i. Those who wish to conduct the analysis for the district as a whole should ignore the subscript i and treat each variable as being applicable to the entire school system. Similarly, the option of computing the expected effective enrollments for individual subject areas or educational space types is available. The number of such subject areas and the criteria for allocating a particular course or group of courses to a specific category must be left to the discretion of each user. Thus, for example, some districts will want to consider all academic courses individually, others will want to separate those requiring "regular" versus "large" classrooms, and still others will be content to lump them all together.

In considering possible subject areas, the ultimate use of the estimates should be kept in mind. Because the component is intended to identify the nature and magnitude of future facility needs, distinctions between various subject areas should generally be confined to those which reflect some actual physical differences between educational space requirements. In situations where the district wishes to examine all educational space types together, the j subscripts should be ignored. The variables should then be interpreted as applying to all educational space types combined. This latter approach will usually be more appropriate at the elementary school level where special facilities such as science labs or industrial arts workshops are less prevalent.

The logic in equation 1 represents a modification of techniques developed by Professors Marion Conrad and Basil Castaldi. The product A_{ij} W_{ij} represents the number of periods per week the average student attends classes, at a particular school i in subject area j, if appropriate. Suppose that a district wishes to estimate the effective enrollment at a particular school i in subject area j, e.g., academic subjects requiring standard sized and equipped classrooms. Further suppose that each student at this school takes an average of three classes in this subject area each semester, and that each of these classes meets five periods per week. A_{ij} W_{ij} would therefore equal fifteen. This would mean that an average student spends fifteen periods per week attending courses within subject area j.

The product P_{ij} D_{ij} is the number of periods per week that classes are held. If a specific school holds classes for six periods each day (P_{ij}), five days per week (D_{ij}), then P_{ij} D_{ij} would be equal to thirty. This figure represents the total number of periods per week that classes of this type may be held. In this example, A_{ij} W_{ij} /P_{ij} D_{ij} would be equal to fifteen divided by thirty, or one-half. This ratio would represent the fraction of the school week that an average student spends attending courses in subject area j at the school in question, and would imply that, on average, only one-half of the total number of students (N_i) are actually attending subject area j classes at any given point in time. For this subject area the effective enrollment is one-half of N_i. Therefore the required facility for subject area j need only be large enough to accommodate one-half of the total students at a time. If total enrollment was 800, then only 400 of these students would be expected to attend classes in subject area j during an average class period during the school week. This assumes that class scheduling could be arranged so that all educational space is occupied in each of the periods throughout the school week.

This latter assumption is, of course, often not necessarily possible or desirable. A "utilization factor" is thus incorporated into the equation whereby the user may maintain some desired level of flexibility. As specified by the user, this utilization rate may theoretically range from zero to one. More commonly it will range from .80 to .95, depending on grade level organization and on the unique features associated with a particular school or group of schools. The application of a utilization factor which is less than one serves to increase the implied level of effective enrollment, thereby maintaining a certain amount of space flexibility. If, for example, the district specified a utilization rate of .85, the effective enrollment for the school in the previous example would be 400 divided by .85, or approximately 470. With equation 1 the example can be summarized as follows:

$$
\begin{aligned}
E_{ij} &= \left\{ N_i \left(\frac{A_{ij}\ W_{ij}}{P_{ij}\ D_{ij}} \right) \right\} \Big/ U_{ij} \\
&= \left\{ 800 \left(\frac{3 \times 5}{6 \times 5} \right) \right\} \Big/ .85 \\
&= 470
\end{aligned}
$$

It can readily be seen that a change in any of the variables in equation 1 will significantly impact the resulting measure of effective enrollments. If the school system wished to maintain a higher degree of flexibility, for example, it might choose a lower utilization rate.

With a utilization rate set at .80 instead of .85 in the above example, the effective enrollment level would increase to 500:

$$E_{ij} = \left\{ 800 \left(\frac{3 \times 5}{6 \times 5} \right) \right\} \Big/ .80 = 500$$

If instead, the user wished to reduce the effective level of enrollment, a staggered sessions policy might be considered. With the establishment of a one hour stagger, classes would be held seven periods each day instead of six, and the effective enrollment level would fall to approximately 403:

$$E_{ij} = \left\{ 800 \left(\frac{3 \times 5}{7 \times 5} \right) \right\} \Big/ .85 = 403$$

Each district is encouraged to experiment with alternative values for the variables in the equation. However, it must be remembered that these variables represent actual standards or policy decisions and their modification may involve serious educational program and fiscal drawbacks. The trade-offs associated with such policy changes must be carefully evaluated.

3.2.2 Calculating Required Space

The equation described above serves as a mechanism by which the effective enrollment of a particular school and subject area may be estimated. The next step is to translate this effective enrollment level into some physical measure(s) of the requisite educational space. As previously noted, each district may elect to measure the space in terms of the required number of teaching stations, or the number of square feet, or both. In the case of teaching stations, the effective enrollment is divided by the user specified value for the desired maximum number of students per teaching station as in the following equation:

$$\text{(2)} \qquad RTS_{ij} = E_{ij} \; / \; T_{ij}$$

where RTS_{ij} represents the required number of teaching stations, in school i, subject area j, and where T_{ij} represents a standard for the desired maximum number of students per teaching station, as specified by the district.

If, for example, the effective enrollment level (E_{ij}) had been estimated at 400 students, and if the district desired no more than thirty students at each teaching station (i.e., $T_{ij} = 30$), then the required number of teaching stations would be equal to 13.33. Most districts would then choose to round up to the next highest teaching station.

$$RTS_{ij} = 400 \; / \; 30 = 13.33 \text{ or } 14 \text{ (rounded)}$$

If the district wished to compute a square footage measure of future facility needs, the estimated level of effective enrollments would simply be multiplied by the desired minimum number of square feet per student, as in the following equation:

$$\text{(3)} \qquad RSF_{ij} = E_{ij} \times F_{ij}$$

where RSF_{ij} represents the required amount of square footage, in school i, subject area j, and F_{ij} is the desired minimum number of square feet per student. If, for example, the district wished to allocate a minimum of twenty-five square feet to each student, i.e., $F_{ij} = 25$, then the amount of square footage required to accommodate an expected effective enrollment level of 400 would equal 10,000.

$$RSF_{ij} = 400 \times 25 = 10{,}000 \text{ sq. ft.}$$

Both the students per teaching station and the square footage per student standards will require that each district establish precise definitions of teaching stations and square footage, i.e., gross or net of hallways, storage space, etc. The only requirement of these definitions is that they be strictly and consistently adhered to throughout the Component.

3.2.3 Calculating the Space Surplus or Deficit

The final task involves a comparison of the required facilities with existing school space. This comparison will represent the estimated gap between future facility needs and the existing facilities. Information regarding the direction and magnitude of any such gap should assist the district in evaluating the ability of its existing facilities to accommodate expected future enrollments, while maintaining school standards and policies within an acceptable range. Calculation of the space surplus or deficit will, of course, necessitate that the required and existing facilities be measured in the same units. Either of the following equations may be used:

$$(4) \qquad CD_{ij} = RTS_{ij} - ETS_{ij}$$

and/or

$$(5) \qquad CD_{ij} = RSF_{ij} - ESF_{ij}$$

where CD represents the capacity differential or need, RTS represents the required teaching stations, ETS represents existing adequate teaching stations, RSF represents the required square footage, and ESF represents existing adequate square footage. When CD is a positive number, there is a space shortage, because requirements outstrip existing facilities. Alternatively when CD is negative, existing facilities exceed requirements, causing an excess or surplus space situation. In all cases the capacity differential may be calculated for individual subject area space, individual schools, and/or the whole district.

To complete the previous example, if the existing teaching space within a school consisted of ten adequate classrooms and a requirement for fourteen had been calculated, a space deficit would exist.

$$CD_{ij} = 14 - 10 = 4$$

Similar calculations could be made using net or gross square feet as a measure, providing, of course, that required and existing space were both measured with a similar definition in square feet.

A critical consideration in the above calculations is the adequacy of the existing space. Any analysis that includes unsatisfactory teaching stations or square footage as part of the measure of existing space may seriously distort the final estimates of space need. It is important that a traditional school building survey be conducted to identify inadequate space and those maintenance or rehabilitation costs necessary. This space should then either be removed from the existing space inventory, or retained with the realization that specific improvement costs be included in the Fiscal Component. A number of established survey techniques are referenced in the bibliography.

These considerations are further complicated by the fact that the comparison of required to existing space must be forecast for a series of years. Any space expected to become inadequate at some point during the planning period will have to be recognized in the analysis.

3.2.4 Calculating Required Teachers

The projected capacity surplus or deficit constitutes the major product of the Facility Component. Some school districts will also want to consider the number of teachers necessary to serve the projected student enrollment. This will be especially important for those districts interested in forecasting future operating costs as part of the Fiscal Component.

Two approaches may be used to project required teachers. Those districts with a distinct student-teacher ratio in mind and interested in overall teacher requirements rather than specific subject area requirements may convert projected enrollment into teachers by using the following equation:

$$(6) \qquad RT_i = \frac{N_i \div STR}{TA}$$

where RT_i is the required teachers for school i or for the school district as a whole; N_i represents the projected enrollment; STR represents the average student-teacher ratio; and TA represents the average number of periods taught by a teacher expressed as a percent of all the periods in a school day.

Thus, for example, in a school with a projected enrollment (N_i) of 800 and a desired ratio (STR) of twenty-four students for every teacher, approximately forty teachers would be required if the average teacher taught five out of every six classes (i.e., TA = .83).

$$RT_i = \frac{800 \div 24}{.83} = 40.2$$

A second approach may be more appropriate for districts that want to calculate the required teachers for specific subject areas.

$$(7) \qquad RT_{ij} = \frac{\left(E_{ij} \times W_{ij}\right) \div STR_{ij}}{TA_{ij}}$$

All the terms have been previously defined. The numerator is the number of student periods per week divided by average classroom size which yields class periods per week for a given subject area. The denominator is the average number of classes taught each week by a teacher for this subject area. Note, in this case the average should be expressed as a total number of classes, rather than as a fraction as contained in Equation 6.

Using this formula, if 600 students wanted to take subject area x, in a school district where the average teacher of this subject area taught twenty-five classes per week, and the average class size consisted of twenty-two students, then approximately six teachers would be required.

$$RT_{ij} = \frac{\left(600 \times 5\right) \div 72}{25} = 5.5$$

Independent of the approach used, the number of required teachers will have to be expanded to account for counselors, librarians, administrative and other support personnel. A suggested approach is presented in the Fiscal Component.

3.3 FACILITY COMPONENT PROCEDURES

The basic instructions necessary to carry out the facility analysis can be completed with the use of two forms. Form A provides the basic work sheet with which space requirements can be calculated for any time period into the future. Form B uses historical information to determine two of the important variables that are subsequently used on Form A. The completion of these two forms will allow analysis at any level of detail desired.

The procedures require the assemblage of an extensive amount of information. Specific data categories are summarized below, along with their typical source and sample values. These values are used to illustrate the Facility Component procedures in the example at the end of the report.

Form	Information	Sample Values	Source
A,B	School Name	T.J. High	User supplied
A,B	Subject Area	"Academic"—10 courses	User defined
A	Planning Period	10 years	User defined
A	Projected Enrollment	880 (1975) to 479 (1985)	Enrollment Component
B	Historical Course Enrollment	180 in Math I (1971), etc.	User supplied
B	Historical Periods per Course	5 times per week—Math I (1971), etc.	User supplied
A	Periods per Day	6	User defined
A	Days per Week	5	User defined
A	Utilization Rate	.90	User defined
A	Desired Students per Teaching Stations	25	User defined
A	Existing Teaching Stations	12	User supplied
A	Desired Sq. Ft. per Student	30	User defined
A	Existing Sq. Ft.	9000	User supplied

At the outset several preliminary decisions must be made regarding the time frame, focus, and measures of space to be used in the procedures.

Step 1. Planning Period. Select an appropriate time horizon. Those school districts that have conducted the Enrollment Component will have already evaluated the trade-offs between the need for an adequately long planning period and increasing levels of uncertainty. Those that have not yet established a time horizon must attempt to arrive at some reasonable balance between these two conflicting considerations. The procedures outlined below are applicable for any number of years.

Once a time frame has been selected, indicate the forecast years above each column in Form A, beginning with the current year and extending through the last year of the planning period. The current year is included to provide a check on the validity of the procedures being used.

Step 2. School and Subject Focus. Select the appropriate level of detail at which to conduct the analysis. The longer the planning horizon is extended, the more difficult detailed analysis will become. Subject area enrollment is likely to vary considerably in response to long-term social, legal, and economic trends. Therefore, in very long-range planning situations, many districts will want to focus on district-wide requirements. Where a shorter time-frame is used, individual school and subject area forecasts may be more useful. Experimentation with different levels of analysis is encouraged.

Those districts wishing to conduct the analysis of future facility needs on a district-wide basis for all courses together should complete only one copy of Form A and Form B. In this case, each variable used in Form A and Form B will represent a district-wide measure, and subscripts i and j referring to a particular school and subject area should be ignored.

Those wishing to conduct the analysis separately by school will need to complete Forms A and B for each school within the school system. In this situation the resulting values on each copy of Form A must be added together to derive totals for the school district as a whole.

Districts wishing to conduct the analysis by subject area must define each variable in Form A and B for one subject area only, completing separate forms for each subject area or educational space type to be examined. Finally, those wishing to examine specific subject areas within a particular school must consider each variable in Form A as it applies to the particular subject area j within school i. In this case i times j copies of Forms A and B would have to be completed to analyze the entire district. The subsequent steps may not always explicitly refer to the school or subject area. However, it must be kept in mind that the treatment of each variable is implicitly associated with a particular school and/or subject area if the district has chosen to pursue those levels of detail.

Once the level of analysis (and therefore the number of forms) has been selected, the headings must be completed. Fill in the lines at the top of Forms A and B, identifying the appropriate school name and subject area or educational space type, if applicable.

Step 3. Measure of Space. Identify appropriate definitions for teaching stations and/or square footage. The district should select those definitions with which it is most familiar. The precise definition given to these two measures of educational space will not affect the reliability of the procedures, as long as the definitions are used consistently.

If only the teaching station measure is to be used, all reference to square feet (Form A, lines 16, 17, 18 and 19) should be blocked out. Alternatively, if only square feet will be used, then reference to teaching stations (Form A, lines 12, 13, 14 and 15) may be disregarded.

In all cases the definitions associated with whichever measures are used should be written and agreed upon by all members involved in the study.

Form B Instructions. The data collection necessary to conduct the analysis begins with Form B. Its purpose is to make possible the computation of historical values for the average number of courses taken by each student and for the average number of class periods (or hours) per course each student attends in a typical school week (variables A_{ij} and W_{ij} respectively). The historical values are calculated in order to assist in estimating future values for these variables which serve as input to Form A.

Step 4. Historical Course Offerings. Identify those courses which have been offered within this subject area or educational space type in recent years. The past five years is suggested. These course titles should be placed in the first column of Form B. It should be re-emphasized that the criteria used to differentiate between various subject areas should reflect potential differences in physical space requirements. If, for example, two seemingly different courses, such as music and social studies, have similar types of physical space requirements, then the two courses should be placed in the same educational space category. The number of educational space categories and the specific criteria for their delineation are left to the discretion of the user. Those who do not wish to examine explicitly the demand for various types of space may treat all educational space types in a single category. Those who do not want to differentiate courses, e.g., in some elementary school situations, may simply enter the words "all courses."

Step 5. Historical Years. Indicate the years for which the historical data is to be computed above each of the remaining five columns on Form B; include the current school year. In the interest of saving time, some districts may prefer to collect fewer than five years of historical data.

Step 6. Course Enrollment. Each year on Form B encompasses three sub-columns. For each course identified in the first column of Form B, determine the course enrollment, i.e., the number of students that signed up for that course, during the previous and current school years. Place this course enrollment information in sub-column a for each year. When any individual courses have been grouped together, e.g., if three different subjects are combined into social science or history, care must be taken to insure that the course enrollment equals the sum of individual enrollments in each course.

Step 7. Course Periods per Week. Enter into sub-column b the average number of class periods per course which each student was required to attend during a typical school week. This number should also be entered for the previous and current years.

Step 8. Student Instruction per Week. For each year and each course identified on Form B, multiply the course enrollment in sub-column a by the number of class periods per course which each student attended weekly in sub-column b. Enter the resulting products in sub-column c. At this point the basic data necessary to calculate the average number of courses taken per student (A_{ij}) and the average number of periods per course attended by a student in a typical week (W_{ij}) has been assembled. The data might look like the following for a secondary school situation where three science courses were being analyzed in one subject area category because of similar space requirements. Note that only two of the five-year columns have been completed in this example.

SCHOOL (i) T. J. HIGH SCHOOL

COURSES PER STUDENT (A_{ij}),
PERIODS PER COURSE (W_{ij}) by SUBJECT AREA

	Year 1971 – 72			Year 1972 – 73		
COURSE NAME	Course Enrollment a	Course Periods Per Week b	Students Per Week c	Course Enrollment a	Course Periods Per Week b	Students Per Week c
CHEMISTRY I	180	5	900	191	5	955
CHEMISTRY II	35	2	70	60	3	180
BIOLOGY	87	3	261	84	3	252

EXAMPLE—FORM B: SECONDARY SCHOOL

In this subject area, 180 students took Chemistry 1 during the 1971-72 school year, meeting five times per week. As such 900 Chemistry 1 "seats" were occupied during a typical week. By contrast Chemistry II had far fewer students and met only twice a week.

If all elementary space requirements were being analyzed on a district-wide basis and there was no desire to separate specific courses or space types, the data might be entered as below. This example assumes 800 students in 1971-72 attending six classes per day, five days per week.

Of course, in this simple example, the information would not be necessary to obtain variables A_{ij} and W_{ij}. In situations where two or three elementary space types were under consideration, e.g., regular classes, music room, and art room, separate subject areas would be appropriate.

SCHOOL (i) G. WASHINGTON ELEMENTARY

COURSES PER STUDENT (A_{ij}),
PERIODS PER COURSE (W_{ij}) by SUBJECT AREA

COURSE	Year 1971 – 72			Year 1972 – 73		
	Course Enrollment a	Course Periods Per Week b	Students Per Week c	Course Enrollment a	Course Periods Per Week b	Students Per Week c
All elementary classes	4800	5	24000	5100	5	25500

EXAMPLE–FORM B: ELEMENTARY SCHOOL

Step 9. Average Courses per Student (A_{ij}). Add the course enrollments, sub-column a, for all courses identified in Form B, for each of the past years and enter the respective totals on line 1 of the form. Then enter the total number of students enrolled for each of these years, including the current year, on line 2 of Form B. This information will have been assembled as part of the Enrollment Component. Finally, for each of the previous years under consideration, divide line 1 by line 2 and enter the result on line 2 of Form B. These values will represent the average number of courses in a given subject area taken per student (A_{ij}) in each of the previous years.

Step 10. Average Periods per Course per Week (W_{ij}). The next step is designed to calculate the average number of periods that a course meets during a week. Add the values found in sub-column c for all courses identified on Form B, for each of the previous years. Enter the respective totals on line 4 of the form. For each of the years, divide the value on line 4 by the value on line 1. This quotient (W_{ij}) should be entered on line 5 of the form. The calculations required in steps 9 and 10 should be entered on the bottom half of Form B, in accordance with the following example. The subject area consisting of three science courses for a secondary school is again presented.

a = Course Enrollment
b = Course Periods Per Week
c = Students Per Week

	Year 1971 – 72			Year 1972 – 73		
	Sub-columns			Sub-columns		
	a	b	c	a	b	c
1. Total: sum of sub-column a	302			335		
2. Number of students enrolled	290			264		
3. Line 1/Line 2 (A_{ij}) Courses per student	1.04			1.26		
4. Total: sum of sub-column c			1231			1387
5. Line 4/Line 1 (W_{ij}) Periods per course			4.08			4.14

EXAMPLE–FORM B: SECONDARY SCHOOL

In the elementary grade example, where all spaces are being treated together as one subject area, the lower left portion of Form B would appear as follows:

	Sub-columns			Sub-columns		
	a	b	c	a	b	c
1. Column a. Total	4800			5100		
2. Number of Students Enrolled	800			850		
3. Line 1/Line 2: (A_{ij}) Courses per Student	6			6		
4. Total: sum of sub-column c.			24000			25500
5. Line 4/Line 1: (W_{ij}) Periods per Course			5			5

EXAMPLE—FORM B: ELEMENTARY SCHOOL

In this simple problem, it will be noted that the calculated variables (A_{ij} and W_{ij}) are not different from the basic input data used in the previous steps. Every student is expected to attend class six times per day, and every class meets five times per week.

Form A Instructions. Once the above entries have been completed for a given subject area, all subsequent calculations can be recorded on Form A. It should be recalled that for every Form B there should be a corresponding Form A, for that specific school and/or subject area.

Step 11. Enrollment (N_i). Enter the current and the forecast levels of enrollment on line 1. If the district is conducting the analysis for each individual school within the district, the number of students entered on Form A should represent the expected enrollment levels at this school only. In this situation a method may have to be devised for allocating total system enrollments to individual schools. This method might be based on relative school capacities where attendance area boundaries are flexible. In situations where these boundaries are more rigid, it might be based on sub-geographic area forecasts generated in the Enrollment Component or derived independently.

Step 12. Average Courses per Student (A_{ij}). The historical values of A_{ij} recorded on line 3 of Form B may now be used to assist in estimating future values for this variable. Enter the current value of A_{ij} in the current-year column of line 2 on Form A. If some trend is suggested by the historical values recorded on Form B, the user may choose to extrapolate this trend and enter the estimated future values of A_{ij} on line 2 of Form A. If there is no discernible trend from the previous values of A_{ij}, an average value for this variable can be calculated and used as an estimate for future years. In either case, careful consideration should be made of all factors likely to have a potential impact on the average number of courses of a particular type which might be taken by students in each year during the planning period. The future values for A_{ij} should reflect these considerations accordingly.

Step 13. Course Enrollment (N_{ij} x A_{ij}). Multiply line 1 by line 2 and enter the resulting products on line 3 for the current year and all future years over the planning period. These values will represent the expected course enrollment at school i, in subject area j, if applicable.

Step 14. Periods per Course per Week (W_{ij}). The historical number of class periods or hours per course which each student is expected to attend in a typical school week (W_{ij}) has been recorded on line 5 of Form B. They may now be used to assist in estimating future values for this variable. Transfer the current value of W_{ij} from Form B to the current year column of line 4, in the corresponding copy of Form A. Again, if some trend in the historical values is apparent, future values may be extrapolated. If no trend is discernible, the district may wish to use the historical average as an estimate of future values for W_{ij}. Any factors which may serve to influence the future values of this variable should be considered as part of this process. The estimated average number of class periods or hours per course each student attends in a typical school week should be entered on line 4 of Form A for each year out to the planning horizon.

Step 15. Student Periods per Week (N_i x A_{ij} x W_{ij}). Multiply line 3 by line 4 of Form A and enter the results on line 5. The values found on line 5 represent the total number of student-periods per week which will be required in each year over the planning period.

Step 16. Periods per Day (P_{ij}). Enter the current and expected number of class periods per day in which classes are held on line 6 of Form A.

Step 17. Student Days ($N_i \times A_{ij} \times W_{ij} \div P_{ij}$). Divide line 5 by line 6, Form A, and enter the resulting quotients on line 7. These values will represent the number of student-days, where a school day is equal to P_{ij} periods, per week which must be accommodated in the current time period and in each year over the planning period.

Step 18. Days per Week (D_{ij}). Enter on line 8, Form A, the current and expected number of days per week during which classes are to be held. This will usually be five.

Step 19. Enrollment per Period ($N_i \times A_{ij} \times W_{ij} \div P_{ij} \div D_{ij}$). Divide line 7 by line 8, Form A. Enter the results of the division on line 9. This figure will represent the number of students which are expected to be in attendance at any point in time during the school week. Sufficient space must be provided to accommodate them.

Step 20. Utilization Rate (U_{ij}). Enter the desired maximum utilization rate for each year on line 10 of Form A. This rate must be equal to or less than one; it will insure the flexibility necessary to resolve scheduling and other administrative problems.

Step 21. Effective Enrollment. Divide line 9 by line 10, Form A, and enter the results on line 11. The values will represent the effective enrollment expected in each year up to the planning horizon, for school i and/or subject area j.

At this point, the most laborious part of the analysis has been completed. The expected effective enrollments for each year may now be converted into measures of facility needs, either in terms of the number of teaching stations or the amount of square footage which will be necessary.

School districts wishing to consider the square footage measure of facility needs should proceed immediately to the instructions for step number 26. Those preferring to compute the implications of the expected future effective enrollments in terms of teaching stations should start with the instructions for step 22.

Step 22. Students per Teaching Station (T_{ij}). Identify the desired maximum number of students per teaching station and enter the value on line 12, Form A. Note that this standard can be varied, if desired, for different years in the future.

Step 23. Required Teaching Stations (RTS_{ij}). Divide line 11 by line 12 and enter the resulting quotient on line 13 of Form A. These values represent future facility needs as measured in terms of the required number of teaching stations.

Step 24. Existing Teaching Stations (ETS_{ij}). The final aspect of the analysis requires a comparison of future facility needs with the existing school plant. Enter existing teaching stations that are considered adequate for use on line 14. If any new stations are already programmed for the future, e.g., if a new addition is under construction, or if some stations are in such bad shape that they are expected to become unusable, these anticipated changes should be noted for the appropriate years. If more than one subject area or educational space type has been defined, caution should be used in assigning the existing teaching stations among the various subject areas or educational space types in order to avoid double counting.

Step 25. Teaching Station Need. Subtract line 14 from line 13 and enter the results on line 15 of Form A. These values will indicate the existing and future shortage or surplus of teaching stations over the planning period. If the values on line 15 are positive, this indicates a shortage of teaching stations. Additional space will be needed, or some of the district standards and policies must be changed in order to accommodate expected future enrollments. If, on the other hand, the values on line 15 are negative, a surplus of teaching stations is implied.

Step 26. Square Feet per Student (F_{ij}). If the space need is to be measured in square feet, the desired minimum number of square feet per student should be entered on line 16 of Form A. The user may define this standard in net or gross square feet, as long as the same definition is used for all facilities.

Step 27. Required Square Feet (RSF_{ij}). Multiply line 11 by line 16, Form A. The resulting products provide a measure of future facility needs in terms of the required amount of square footage. Enter these values on line 17.

Step 28. Existing Square Feet (ESF_{ij}). Enter the existing amount of square footage on line 18. If more than one category of educational space or subject area has been examined, caution must be exercised in allotting the total amount of square footage to the various subject area categories so that no double counting occurs.

Step 29. Square Footage Need. Subtract line 18 from line 17, and enter the results on line 19 of Form A. These values provide a measure of the existing and projected surplus or shortage of square feet for each year up to the planning horizon. If the value on line 19 is positive, this means that a space shortage exists or is expected. If the value on line 19 is negative, a surplus is indicated. The value itself will serve as an approximation of the size of the surplus or shortage in terms of square feet.

3.4 Analysis

The completion of Forms A and B as described in the preceding section yields an initial measure of the nature and magnitude of the school system's future facility needs. These needs will obviously vary in response to some factors, such as enrollment or state imposed standards, that are largely beyond the control of the local school district. Other factors, such as a utilization rate, will be directly susceptible to local district manipulation. It is important that the procedures be repeated to examine the impact of a change in local conditions, standards, and policies. It is equally important that alternative capital plans be tested using the procedures.

3.4.1 Selecting Standards and Policies

The district's standards and policies should be considered in light of the district's ability to meet the educational needs of the community. Thus, some possibilities, such as "double sessions," may automatically be beyond consideration as a potential facility deficit solution because of their perceived educational shortcomings.

If the user is relatively unfamiliar with certain variables found in the procedures, the initial entries may be determined by calculating current values from existing historical data.

For example, the current utilization rate or space per student may be calculated and used. In specifying desired standards and policies, many factors should be taken into consideration. Professional teachers' organizations, for example may exert a significant influence on policy decisions, such as the desired maximum number of students per teaching station. The public in general may express strong concern over some standards or policies, such as the length of the school day. In addition to the interests of local individuals and groups, current and expected national trends in education should also be considered. For example, for many years square footage standards were based on the number of square feet required by a pupil sitting at a stationary desk. As individualized instruction has become more important in contemporary educational thinking, the instructional settings are less restricted by stationary desks. It is important to remember that the only proper values for the standards or policies to be used are those tailored to the educational needs of the community.

A considerable range of values for certain of the standards and policies may be acceptable to the needs and goals of school districts. The user is thus encouraged to repeat the procedures of this component in order to evaluate the impact of altering these standard or policy variables. The possibility of averting a critical shortage of educational space by relaxing the students per teaching station standard or by using staggered sessions might be explored. While some of these solutions will not seem ideal or even desirable, they may nonetheless be preferable to the large expenditures associated with the construction of a new school or the expansion of an existing facility. This will be especially true if a projected shortage is expected to be a short-lived phenomenon. Repeating the procedures using alternative enrollment forecasts may also yield valuable insight into the risks associated with the forecasts and with any proposed capital plan intended to address the facility needs problem.

One potential policy alternative, the twelve-month school year, has not been explicitly incorporated into the procedures of this component. A twelve-month school year may have some serious drawbacks, such as the necessity of school air conditioning, but it can represent a feasible alternative to expected over-crowding. In order to examine the implications of such a policy, the school district should repeat the procedures outlined in the previous section, modifying the expected number of students enrolled (N_i) by multiplying this number by three fourths (.75). This would reflect the fact that only three-fourths of the total number of students would be attending school in any given month.

3.4.2 Definitions

Each variable included in the procedures of this component has been briefly defined. If the definitions provided are inadequate for a school system's needs, the user is encouraged to modify or expand them as long as such modifications do not interfere with the basic logic used in the technique. Any modified definitions should be clearly specified and agreed on by all of those directly associated with the implementation and subsequent interpretation of the facility planning project. As previously noted, it is important that all definitions be uniformly applied throughout the procedures.

The selection of an appropriate measure of future facility needs, either in terms of teaching stations or square footage or both, has been left entirely to the district. While the use of teaching stations or classrooms will be most familiar, it has not been shown to be a necessarily superior measure. In view of the current popularity of "open" classroom design, the square footage measure may be more appropriate in some cases. This measure may be defined in terms of gross square footage or net square footage (i.e., gross square footage less hallway, storage areas, and other non-teaching space). As long as the district exercises care in the consistent use of one definition or the other, no serious difficulties should be encountered. School systems which are considering renovation may wish to use the gross measure of square footage because of the potential convertability of certain "non-instructional" areas into learning space.

3.4.3 Capital Planning

The measures of facility needs on line 15 and/or line 19 of Form A provide much of the basic information with which specific capital planning strategies can be formulated. The school system is encouraged to consider a variety of possible solutions and then to examine their facility impact. This will involve changing the values on the appropriate line of Form A for the proposed year in which they would take effect, and recalculating the formula.

Specific plans will, of course, vary with the nature and magnitude of the problem. A problem that is concentrated in a few grades or a few geographic sections of the district may be resolved by changing the grade organization, reassigning specific classes to different schools, or revising the attendance boundaries. Other problems will pervade all grades throughout the entire district.

In a declining enrollment situation, the impact of allowing fewer children per teaching space (Form A, line 12) or more square feet per child (Form A, line 16) might be explored. Similarly the effect of devoting a greater amount of space to non-teaching or community uses could be tested by changing the utilization rate (Form A, line 10). The impact of disposing of certain facilities could be examined by adjusting the existing teaching stations (Form A, line 14) or square feet (Form A, line 18) for the correct years.

In a growth situation the same kinds of possibilities would be considered but in the opposite direction. The space implications of more children per teaching space and less space per child, of higher utilization rates, of a new sessions policy, and, finally, of new facilities could all be evaluated. While further plan formulation considerations are presented in Chapter 7, the essential process of designing alternatives cannot be reduced to a check list. Ultimately, the user must develop these based on his judgement, experience, and knowledge of the district.

Chapter 4: Fiscal Component

In Chapter 2, the demand for educational services as determined by projected student enrollment was estimated. In Chapter 3, that demand was translated into facility needs. Chapter 4 will examine the demand for educational services, in terms of their fiscal implications. This necessitates the forecasting of capital requirements, operating expenditures, and revenues, and the development of a fiscal plan whereby revenues and expenditures may be compared and, if necessary, adjusted.

4.1 Overview

It is evident that forecasts of both revenues and expenditures must consider economic conditions and legal restrictions. While this component does not attempt to address all possible situations, it does possess the flexibility that will allow school planners to consider unique conditions which may characterize their district. The result of this flexibility requires that the user make decisions as to how variables will be projected. Also, the uncertainty associated with each variable must be taken into account. However, the user's knowledge of the community and how it is affected by economic factors will ultimately determine the predictive accuracy of the model. Because of fluctuations in economic conditions and policy decisions within the school district, an exact method of dealing with uncertainty cannot be presented. Instead, throughout this component an attempt has been made to isolate those factors which contribute the greatest amount of uncertainty to a forecast and to estimate the effect of these factors on the overall problem of decision making.

4.2 General Design

Chapter 4 is divided into four sections. Section 4.3 deals with future capital expenditures, which may include the construction of new facilities, the improvement of existing facilities, or both. A technique is provided for estimating expected costs in light of general inflationary trends and unique local conditions. Section 4.4 is concerned with forecasting operating expenditures. Two major categories of expenditures are dealt with specifically: employees' salaries and benefits, and other operating costs and services. However, more detailed analysis of separate expenditure categories is possible. The user is encouraged to select that level of analysis necessary to address the particular school problem. Redefinition of the generalized accounts to fit the district's specific accounts may also be in order.

Section 4.5 deals with the projection of revenue from federal, state, and local sources. The forecasting of revenue from local sources is heavily dependent upon forecasting assessed valuation since it is the primary source of local revenue. State aid may be forecast in two manners: first, as a function of assessed valuation per student, and second, as a function of enrollment. The user must choose one technique or design a new technique, depending upon the specific state allocation formula. Total federal revenue is forecast as a percentage of total cost. This approach is recommended because of the differences between school districts in their reliance on federal grants-in-aid. Section 4.5 concludes with the projection of the school district's current bonding capacity. In most cases, the gross bonding capacity is set by law as a percentage of assessed valuation. Current bonding capacity is calculated as gross bonding capacity minus outstanding bonded indebtedness. A tentative bond retirement schedule for any planned bond issues must be developed and a net bonding capacity calculated. At the conclusion of this section, the user will have completed a forecast of: (1) capital requirements, (2) operating expenditures, (3) revenues, and (4) bonding capacity.

In Section 4.6 procedures for developing a fiscal plan are presented. Emphasis is placed on the analysis of the cash flow indicated by a comparison of expenditures and revenues. If the cash flow is positive throughout the planning period and there are no planned bond issues, the only further analysis necessary is evaluating the possibility of a tax reduction. If the cash flow is positive and a bond issue is planned, the schedule of payments must be compared to the school district's revenue to determine if these obligations can be met. If, as the result of a proposed bond issue, the cash flow becomes negative, adjustments will be necessary in the number of bonds retired in any given year, and corresponding changes in the interest payments on the outstanding bonds.

Should it appear that the cash flow will be negative during any of the years of the planning period, changes in either expenditures or revenues must be made. A tax increase, a decrease in services, or a change in some of the standards regarding class size might be considered. In most cases these changes will have an impact on the entire fiscal plan rather than only on the immediate area affected. Moreover, these changes will, of course, influence other aspects of the educational program. Possible fiscal alternatives and their impact are reviewed in this section.

A set of forms is provided to aid in forecasting the particular variables throughout the chapter. In addition, summary forms are provided for purposes of recording the individual projections and comparing revenues and expenditures. These forms will also be used to make adjustments where necessary because of negative cash flows. Each variable such as "assessed valuation," "revenue from property tax," etc., should be entered on the summary forms in keeping with the sequence presented in the text. A line number will be assigned to each variable. Historical data need not be entered on these forms; however, if such data is desired for comparative purposes, the user could modify the forms to include this information. A complete example for all the forms has been included at the end of this report.

4.3 School District Capital Requirements

After completion of the Facility Component, the district will have determined its need for additional space or for the improvement of existing facilities. Because of the influence of future economic conditions on the construction industry, current costs cannot be used for estimating future expenditures. Nor is it within the scope of this chapter to present a detailed technique for projecting construction costs. To incorporate the impact of economic variables on future costs, use of an independent building cost index is recommended. One example is the Dodge Manual for Building Construction Pricing and Scheduling. Projection of the index is based on the percentage change in the index over the past ten years and the user's expectations about future rates of inflation. Form E is recommended to carry out the necessary calculations.

4.3.1 SCHOOL DISTRICT CAPITAL COST FORECASTING PROCEDURES

Projections of future capital costs can be carried out in eight steps, using Form E. Historical building cost figures in the form of an index and estimates of the current costs of each proposed capital improvement are the required data items.

Step 1. Historical Data. Enter the years on Line 1 for which historical data has been collected and those of the planning period. The most recent year for which data is available is entered in Column 10. If fewer than ten years of historical data are available, some columns will be left blank. Enter historical data for the building cost index on Line 2.

Step 2. Percentage Change. Calculate the percentage change in the index (%△BCI). This equals the value of the index in year t, divided by the value of the index in year t-1, minus 1.00. Most users will want to multiply this figure by 100 to convert the number from a decimal to a common percentage. For example, if the index was 281 in 1965 and 288 in 1966, the calculations would yield 2.5 percent, as follows:

$$\begin{aligned}\%\triangle \text{BCI} &= [(\text{BCI}_t \div \text{BCI}_{t-1}) - 1.00]\ 100 \\ &= [(288 \div 281) - 1.00]\ 100 \\ &= (1.0249 - 1.00)\ 100 \\ &\cong (.025)\ 100 \\ &= 2.5\end{aligned}$$

These historical percentages should be entered in the appropriate columns of Line 3.

Step 3. Percentage Change Projection. A projection of the future rate of change in the building cost index must be made on the basis of past trends and expectations regarding future rates of inflation in the local construction industry. For example, if the percentage change in the index has been increasing over the past decade but is expected to level out soon, an average of the past five years' changes or the current year's change could be used for the future values of the index. In light of the uncertainty associated with projecting future rates of inflation, the user is encouraged to plot the historical values of the index to determine if there is a discernible trend. Next, several projections should be made assuming different percentage rates of growth. By doing this, for example, the impact of a seven percent versus an eight percent rate of change will be made apparent. Lines 3a and 3b have been provided, in addition to Line 3, for comparing different assumed rates of change. The projections for the percentage change in the construction index are entered in each row for all the years of the planning period.

Step 4. Cost Index Projection. Project the building cost index using the following formulas:

$$(1)\quad \%\triangle \text{BCI}_t \times \text{BCI}_{t-1} = \triangle \text{BCI}_t$$

$$(2)\quad \triangle \text{BCI}_t + \text{BCI}_{t-1} = \text{BCI}_t$$

Equation (1) requires that the value on Line 3 for time period t be expressed in decimal form and multiplied by the value on Line 2 for the period t-1. In Equation 2 this result is then added to the value on Line 2, time t-1, and entered on the same line for the following year. The subscript t refers to the year. Thus, for example, the projected building cost index for one year into the future (year t+1) would be calculated as follows, in a situation where the current index was 467 and a 7.4 percent increase was anticipated:

$$(1)\quad .074 \times 467 = 34.6$$

$$(2)\quad 34.6 + 467 = 501.6 \text{ or } 502$$

If alternative projections of %△BCI have been entered on Lines 3a and 3b, two additional estimates of the building cost index will be possible. These should be entered on Lines 2a and 2b respectively. Some users will, of course, shorten the above steps by multiplying the building cost in year t times one plus the anticipated percentage change in year t + 1 to obtain the new index. The calculations should be repeated for each year of the planning period.

Step 5. Facility Cost Estimates. Estimate the cost of any additional facilities or improvements to existing facilities as determined in the Facility Component, in terms of current costs. Local authorities such as architects or builders should be consulted in making these estimates. Enter the estimates on Line 4 in the column corresponding to the year in which the additions or improvements will be initiated.

Step 6. Deflated Building Cost. Divide each entry in Line 4 by the entry in Column 10 of Line 2. Enter these figures on Line 5. When multiplied by 100 this procedure will yield what the facility might have cost in the index's base year (i.e., the year when BCI = 100).

Step 7. Future Building Costs. Multiply the entries on Line 5 by the corresponding entries on Lines 2, 2a, and 2b. Enter these figures on Lines 6, 6a and 6b respectively. This will reflect the expected cost in "inflated" dollars for the year in which the facility is to be built.

The entries on Line 6 should be recorded on Summary Form A on Line 101. If more than one estimate has been made, enter the one which appears most reasonable. However, the user is encouraged to retain the other estimates for evaluating the fiscal plan.

Step 8. Planned Land Expenditures. In cases where additional facilities are needed, it may be necessary to acquire land. The cost of land will vary directly with local conditions such as the availability and proximity of land to the population to be served. Again consultation with local sources is encouraged to assist in the cost estimation. Planned Land Expenditures are entered on Line 102 of Summary Form A for the appropriate years. Total Capital Expenditures is the sum of Lines 101 and 102. This total is entered on Line 103 of Summary Form A.

4.3.2 Building Cost Example

The previous steps may be summarized with an example using data compiled for a fictitious school district. Form E and Summary Form A have been completed at the end of this document according to the procedures stated above. The planning period is for ten years. Historical data for the building cost index was collected for the period 1965-74. The most recent year for which data was available is 1974; hence the 1974 information is assigned to Column 10.

As suggested in the procedures, %△BCI has been calculated three different ways. The first projection, Line 3, Form E, is based on the assumption that past trends will stabilize and remain constant. A five year average has been calculated, yielding a 7.4 percent annual increase in the BCI, which is projected to continue for the next ten years. A second projection (Line 3a) is based on the assumption that the %△BCI will remain constant at a slightly higher level than that of the current figure. The third projection is based on the assumption that the %△BCI will fall gradually and level off at a rate more in line with historical trends over the past thirty-five years, namely, a constant rate of increase of approximately four percent a year.

The example assumes that the school district will build new facilities in 1975 and 1976 which would cost $175,000 and $700,000 respectively if they were constructed now (Line 4, Form E). Line 5 represents the cost (divided by 100) of the buildings if they had been built in the index base year, the year in which the BCI = 100. These deflated costs have been multiplied by the BCI for the years in which the facilities are supposed to be built (Lines 6, 6a, 6b) to yield future building costs.

Planned land expenditures have been proposed for 1975-79 (Line 102, Summary Form A). The effect of expected inflation has been included in these estimates.

4.4 School District Operating Expenditures

The procedures outlined in this section are organized to coincide with the Recommended Code of Accounts for Expenditures, established by the United States Office of Education. This code includes the following general categories: Salaries and Benefits (Category 100 & 200), Purchased Services (Category 300), Supplies and Materials (Category 400), Capital Outlay (Category 500), and Miscellaneous (Category 600). These categories and their associated sub-categories are defined in detail in Handbook II (revised) of the State Educational Research and Report Series, published by the United States Office of Education.

For forecasting purposes, Categories 100 and 200 have been combined under the general heading "Salaries and Benefits." Categories 300, 400, and 600 are combined under the general heading "Supplies and Services." Category 500 has already been treated separately in Section 4.3. These three categories represent a minimum set of variables for analysis. If a more precise breakdown is desired, sub-classifications of these categories may be projected, using the same techniques outlined below. In districts where a quite different set of accounts is used, redefinition of the expenditure categories in this component is encouraged so that they are applicable to the local situation.

Operating expenditures can be calculated three ways. First, they can be calculated for each school and summarized to obtain a total for the entire district. Second, they can be calculated for only the proposed new schools, or schools to be closed, with the district total developed independently. Third, district totals can be developed without reference to individual schools. In general, it is recommended that expenditure forecasts be made on an individual school basis, for each school directly affected by the facility plan.

The following approach is geared to the analysis of an entire school district; it is equally applicable to an individual school.

4.4.1 Salaries and Benefits

To forecast salaries and benefits, it is necessary to obtain an estimate of the number of teachers expected for each year of the planning period. The number of teachers required to support projected enrollments may be obtained from the Facility Component. If there is reason to believe that actual teachers will vary from those required, adjustments will have to be made.

The total number of employees is forecast by projecting the historical ratio between teachers and total employees and applying this ratio to the projected number of teachers. Alternatively, some districts may elect to add specific categories of employees to the projected teachers, based on knowledge of their administrative and maintenance requirements.

Most districts will determine the future ratio of teachers to total employees, using an historical average or the current value. In some districts, however, the number of employees per teacher will be increasing or decreasing rather than constant. For example, if it is anticipated that a school or schools within the system will be closed, the number of teachers may remain fairly constant while the total number of employees decreases. In view of these situations, the use of a constant as the projected employee/teacher ratio may not always be adequate.

A linear projection of the employee/teacher ratio offers one alternative in such cases; however, its limitations must be noted. It would project the employee/teacher ratio, using a constant rate of increase or decrease in the ratio based on past trends. The assumption that the rate of increase or decrease would be constant in a district might be valid where a gradual change in the ratio had been experienced and was expected to continue. But a linear projection based on rapidly changing historical ratios could result in completely unrealistic employee/teacher ratios over the long run. In such situations professional judgement will be required to make appropriate adjustments to the projections.

To project a varying ratio of employees per teacher, a linear regression technique is recommended. The procedures for this technique are similar to the Curve Type A approach used for time-trend projections in the Enrollment Component.

Average Employee Salary. After determining the expected number of total employees in the future, it is possible to project their total salaries and benefits. The recommended approach relies on the calculation of a projected average salary-benefit per employee, which is then applied against total employees. The technique used to project the average expenditure per employee rests on a number of assumptions; first, that a relationship exists between the average salary in the school system and per capita income in the community; second, that this relationship is not linear; third, that the relationship will remain constant throughout the planning period; and fourth, that accurate independent projections of per capita income for at least the metropolitan area can be obtained. If any of these assumptions does not hold in a particular school system, the resulting projections should be reviewed with caution.

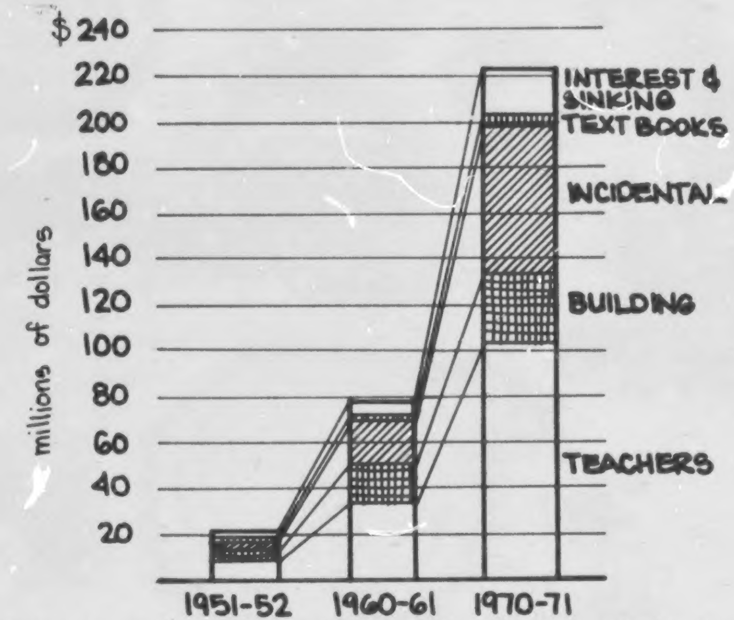
The recommended forecasting technique assumes an exponential relationship between average teacher salaries and benefits and per capita income. It rests on the assumption that average salaries and benefits have risen faster and will continue to rise faster than per capita income. In long-range forecasting situations this may yield unreasonably high average expenditures. If there is evidence that a linear relationship exists between the two variables, some users may choose to forecast the average salaries and benefits, using a linear rather than exponential regression.

It is also evident that the third assumption will often be suspect. The absence of a consistent relationship between per capita income and salaries is likely to be especially true in districts where the average salary has risen rapidly in the past and is expected to level off in the future. In these cases, the user is encouraged to view the results with caution and to adjust them where necessary. Of course, in all cases inflation will continue to exert an upward pressure on salaries and benefits, as well as on per capita income in general.

Independent projections of per capita income may be obtained from the Office of Business and Economic Research Statistics (OBERS) within the Department of Commerce. In some areas, local banks, planning agencies, or business and industrial growth associations may also have recent projections. The challenge will be to obtain a set of projections that appear reasonable in light of current inflationary patterns. If such projections cannot be obtained, or if unique school district factors seem likely to prohibit a constant relationship between average salary-benefit expenditures and per capita income, the user is encouraged to seek a different forecasting technique. Selection of a percentage increase rate based on a review of past increases, and judgement as to future conditions may be an adequate approach. Steps similar to those outlined for projecting the building cost index would be used.

Projected Salary. Given a forecast of total employees and of expected average salary-benefit expenditures, total school district outlays for personnel can be estimated for each year of the planning period. If a long-range planning horizon is being used, the amount will probably appear extremely large in the latter years, thereby reflecting the impact of inflation.

Considerably more detailed salary forecasting techniques may be devised by those users with the time and interest. This will be especially true if attention is devoted to the number of teachers by salary grade; those likely to be hired, promoted, and retired; the philosophy of the teachers' union and school board; and the salary structure of surrounding districts. However, for long-range forecasts there is no evidence that these more disaggregated approaches will be more accurate than that recommended above.



* based on reports published by the Superintendent of County Schools

TOTAL SCHOOL SYSTEM
OPERATING EXPENSES 1950-70*
ST. LOUIS COUNTY

4.4.2 SALARY AND BENEFIT FORECASTING PROCEDURES

Forecasts of total school district expenditures for salaries and benefits are carried out in two parts, a forecast of total employees and a forecast of average expenditures per employee. When multiplied together, the result is an estimate of total salary and benefit outlays over the planning period. All procedures can be carried out using Forms F, or F1, and G.

Task 1: Routine Employee Projections. This approach uses Form F. Required data items are historical information regarding total teachers and total employees within the district, and forecasts of future teachers by year.

Step 1. Historical Data. Line 1 of Form F contains the years, with the most recent year for which data exists entered in Column 10. Enter historical data on the total number of employees on Line 2 as determined from school records. Enter historical and projected numbers of teachers on Line 3.

Step 2. Employee-Teacher Ratio. Calculate the number of employees per teacher. This is achieved by dividing Line 2 by Line 3. The figures are entered in the appropriate columns of Line 4.

Step 3. Projected Ratio. Project the number of employees per teacher. The projection method used will depend upon past trends and the user's expectations about future developments. If the number of employees per teacher has been approximately constant in the past and is expected to remain the same, project Line 4 by using the average of the historical entries in Line 4, or the last historical entry. Enter the projected ratio in the remaining columns of Line 4. As noted, some users may want to project the ratio based on the rate at which it has been changing historically, in which case the alternative method is recommended.

Step 4. Projected Employees. Multiply the ratios on Line 4 times the projected number of teachers on Line 3, corresponding to the years in the planning period. Enter the projected employee totals in the appropriate columns of Line 2. Proceed to Task II.

Task I: Alternative Employee Projections. This approach is recommended when the user desires to make a linear extrapolation of the employees per teacher ratio. Form F1 is used. It corresponds to Form E in the Enrollment Component which is used to make linear projections (Curve Type A). Historical employee per teacher ratios are the only necessary data. Reference to the Type A Time Trend Procedures in the Enrollment Component is recommended.

Step 1. Complete Lines 1 through 6 as indicated in Steps 1 through 6 of the Enrollment Component, Time Trend Projection, Type A.

Step 2. Enter historical data on the number of employees per teacher in the appropriate columns of Line 7.

Step 3. Complete Steps 8 through 17, entering the data in the corresponding lines of Form F1. Line 17 will contain the projection of employees per teacher. Complete Line 4 of Form F with the corresponding entries from Line 17. If the projected ratios appear unreasonable, they should be adjusted accordingly.

Step 4. Multiply Line 4, Form F times Line 3 and complete Line 2 with the resulting product. This yields projected employees for each year of the planning period.

Task II: Salary and Benefit Projections. Form G is used to forecast total annual school district expenditures for salary and benefits by multiplying the projected number of employees, determined above, times the projected average expenditure per employee. The average expenditure is forecast as an exponential regression against an independent forecast of per capita income in the community. Historical annual outlays for salaries and benefits, historical total employees, and historical and projected per capita income are the data requirements.

Step 1. Line 1 contains the years with the current year entered in Column 10. Enter the historical and projected total employees on Line 2. Enter historical data on total salaries and benefits on Line 3. To facilitate use of the form, this may be recorded in thousands.

Step 2. Calculate the average salary and benefit per employee by dividing Line 3 by Line 2. The results are entered on Line 4.

Step 3. Enter per capita income projections on Line 5. These may be obtained from the Department of Commerce's Office of Business and Economic Research Statistics.

Step 4. Using a natural logarithm table, find the logarithms of the average salary per employee. Enter these figures on Line 6.

Step 5. Calculate the arithmetic average of Line 6 and enter this in Column 1 of Line 7.

Step 6. Calculate the arithmetic average of the entries on Line 5 for which there are corresponding entries on Line 4. For example, if ten years of historical data for both average salary per employee and per capita income have been collected, these ten entries on Line 5 may be used. However, if only seven years of historical data exist for average salary, then only seven years of per capita income projections may be used. The first three historical years would be disregarded. This average is entered in Column 1 of Line 8.

Step 7. Subtract the value on Line 8 from each entry on Line 5 which was used to compute the average. Enter these figures on Line 9.

Step 8. Square each entry on Line 9 and enter the results in the corresponding columns on Line 10.

Step 9. Calculate the sum of Line 10. Enter this figure in Column 1 of Line 11.

Step 10. Multiply the entries on Line 9 times the corresponding entries on Line 6. Enter these figures on Line 12.

Step 11. Calculate the sum of the entries on Line 12. Enter this figure in Column 1 of Line 13.

Step 12. Divide the entry on Line 13 by that on Line 11. Enter this figure in Column 1 of Line 14.

Step 13. Multiply the entry on Line 14 by the entry on Line 8. Enter this figure on Line 15.

Step 14. Subtract the entry on Line 15 from the entry on Line 7. Enter the difference on Line 16.

Step 15. Multiply the entry on Line 14 times the projected per capita income for each year of the planning period on Line 5. Add these products to the entry on Line 16, and place in the appropriate columns of Line 17. Line 17 now contains the natural logarithms of the projected average salaries and benefits.

Step 16. Using a natural logarithm table, determine the antilog of each figure on Line 17 and enter these antilogs on Line 18. The figures are the projected average salaries and benefits for the school district over the planning period.

Step 17. Multiply the entries on Line 18 times those on Line 2, which correspond in both cases to the projected totals. These products are the projected total salaries and benefits and are entered in the remaining columns of Line 3. The user should examine these totals and adjust where necessary on the basis of prior knowledge or expectations. Enter these totals on Line 104 of Summary Form A.

4.4.3 Salary and Benefit Projection Example

The use of Forms F, F1, and G have been illustrated at the end of the report with sample data for hypothetical school districts. The employee/teacher ratio has been forecast by simply extending the current value (1.90) into the future. Note, that if all nine years of historical ratios had been used, a lower average value (1.84) would have been calculated. However, given the upward trend since 1970, use of the current ratio appears appropriate. The alternative technique has been used in a different district to extrapolate the ratio. This district also has a rising trend which is projected to grow linearly. The results should be used cautiously, especially for long-range forecasts.

Using Form G, salaries and benefits have been projected to rise from their 1974 level of approximately $20,348,000 to almost $34,000,000 in 1984. Historical data, including total employees, total salaries and benefits, and per capita income, was available for the period 1966-1974. Notice that "total employees" was not listed for 1965. Therefore, 1965 was eliminated from all calculations. The projections have been carried out to the nearest thousand, and recorded on Summary Form A. In the example, the first projected value for average salaries and benefits (Column 11) is less than that of the previous year, even though the long-range projection indicates a rapid increase. This initial decline is the result of the forecasting technique, and the fact that in some past years (e.g., 1971 to 1972) there was a decline, rather than increase, in the value. If this decline appears unreasonable, an adjustment for the immediate forecast might be considered.

4.4.4 Supplies and Services

In most school districts, salaries and benefits will constitute between seventy-five and ninety percent of the total operating costs. Because the expenditures for supplies, services, and other non-salary operating costs are often relatively insignificant, some users may elect not to project them directly. If this is the case, total operating costs may be projected by calculating the historical ratio between salary and benefits and total operating costs, and then applying either an average or projected ratio against the future salary and benefits. For example, if a school district had historically devoted ninety percent of its operating costs to salaries and benefits and believed that percentage likely to continue in the future, it could divide any projection of salary and benefit costs by .9 to obtain total operating costs. The projected total operating costs are then recorded on Line 107 of Summary Form A.

On the other hand some districts will want to project non-salary expenditure categories directly. In general this should be performed on a disaggregated basis. Each major supply or service category should be analyzed to determine the extent to which it varies, primarily in relation to the number of students, the number of teachers, or the number and size of facilities. The volume or amount of service and supply requirements in the future can then be forecast as a ratio of an independent forecast of teachers, students, or buildings. Projections of unit costs for each supply or service category are necessary to complete the process. They can be extrapolated in light of historical values and judgement as to inflationary trends. Multiplication of the unit cost forecast times the value forecast yields a projected expenditure per category for each year into the future.

A compromise approach is illustrated in the following procedures. The total cost of supplies and services is forecast on the basis of expected cost per student times the projected enrollment. This approach involves more work than the simple ratio technique outlined above, but far less effort than a detailed category-by-category analysis.

4.4.5 SUPPLIES AND SERVICES FORECASTING PROCEDURES

The technique recommended for projecting the cost of supplies and services requires that historical cost data be assembled, as well as the past and projected enrollments. Form H is used.

Step 1. Historical Data. Enter the years for which historical data has been collected and the future years for which the projections are to be made on Line 1 of Form H. Column 10 should represent the year for which the most recent data is available. Enter historical and projected enrollment information on Line 2. Enter historical data regarding the total cost of supplies and services on Line 3.

Step 2. Divide Line 3 by Line 2 to obtain the historical cost per student of supplies and services. Enter these figures in the appropriate columns of Line 4.

Step 3. Calculate the incremental change in cost per student from year to year. The change for year t is calculated by subtracting the Line 4 figure in year t-1 from the figure in year t. These totals are entered on Line 5. Note that in situations where the cost has dropped from one year to the next, a negative number will result.

Step 4. Calculate the annual percentage change in the cost per student by dividing the entries on Line 5 by the corresponding entries on Line 4. The totals are recorded on Line 6.

Step 5. Calculate the arithmetic average of line 6 and enter this figure in Column 10 of Line 7. If the recent historical data appears substantially different from the older data, it may be appropriate to calculate the average using only data for the past several years.

Step 6. Add one to the quantity entered on Line 7 and enter these figures in each column of Line 8 corresponding to the year for which projections are to be made. The first entry should be in Column 11.

Step 7. Number the columns on Line 9 with consecutive numbers, starting with the number 1, corresponding to each year of the planning period. Thus, Column 11 should contain 1, 12 should contain 2, etc.

Step 8. Raise each entry on Line 8 to the power indicated by the number in the corresponding column on Line 9. For example, 1.09 raised to the second power will equal 1.188 (i.e., 1.09 x 1.09 = 1.188). Record these totals in the appropriate columns of Line 10.

Step 9. Multiply the entry in Column 10 of Line 4, times each entry on Line 10. Enter these totals on Line 11. These totals are the projections of cost per student.

Step 10. Multiply the projected cost per student on Line 11 by the corresponding projected enrollment on Line 2 to obtain the total cost for supplies and services for each year of the planning horizon. These totals should be entered in the remaining columns of Line 3 and on Line 105 of Summary Form A.

4.4.6 Supplies and Services Projection Example

An example of the technique for projecting future non-salary expenditures as a function of anticipated enrollment is illustrated on Form H. In this situation, an average increase of nine percent in the cost per student is anticipated annually in the coming years. This increase would result in a cost per student of approximately $612 in 1984 or (assuming a projection of 24,575 students) just more than $15,000,000.

As noted above, many users will desire a finer breakdown which will necessitate forecasting different items independently. The same procedures can be used. The projections should be based primarily on expectations regarding future rates of inflation. If the user expects an absolute increase or decrease in these expenditures for any other reason (e.g., a cutback because of financial pressures or an increase because of the desire to provide more of a specific service or supply item), the increase or decrease per student should be calculated and added or subtracted to the average cost per pupil (Line 7, Form H) before completing the remaining steps.

Any additional expenditures may be entered on Line 106 of Summary Form A. The total of Lines 104, 105, and 106 should be entered on Line 107 of Summary Form A and the sum of Lines 103 and 107 entered on Line 108. Form A is now complete. Total capital and operating expenditures have been forecast.

4.5 School District Revenues

In this section, methods are presented for forecasting school district revenues from local, state, and federal sources. In general, local revenues will be based primarily on a forecast of assessed valuation; state revenue will be based on forecasts of enrollment and/or assessed valuation; and federal revenues will be based primarily on the historical percentage of total revenue contributed to the district by the federal government. As with the calculation of expenditure projections, many levels of analysis are possible. Some districts may choose to forecast only the major revenue sources, with all other amounts added on as a percentage. Alternatively, every source of funds may be forecast directly.

4.5.1 Local Revenues

The property tax constitutes the main source of revenue from local sources to most public school systems. Additional sources of revenue from local taxation, such as sales, income, or corporate taxes, vary from school system to school system. In most cases, revenue from these specific taxes may be forecast on the basis of either projected enrollment or assessed valuation. If alternative sources of local school district revenue are not covered in this section, the user is encouraged to project these revenues, using the most applicable of the techniques described below.

4.5.1.1 Property Tax Revenue

Two factors contribute to the change in a community's assessed valuation: first, the development of property, including residential, commercial, and industrial activity; and second, inflation as it is reflected in the reassessment of existing structures and the value of new structures. In a sense, these two factors represent two types of growth: real growth based on the increase in the actual number of structures, and monetary growth as reflected in a higher value for new and old structures. To capture both effects, assessed valuation is projected, first, by forecasting the amount of new residential, industrial, and commercial property which will be developed during the planning period; and, second, by adjusting the assessed valuation of existing structures for inflation.

Depending upon the particular school system, assessed valuation can be predicted, using gross or disaggregated data. Gross data, in which no distinction between types of property is made, is recommended for those districts where one type of property dominates, for example, a community that is primarily residential, with little or no industrial or commercial property. Disaggregated data is recommended for those districts in which more than one type of property development is significant and/or shows divergent growth rates.

The steps outlined below can be carried out, using either gross or disaggregated data. If the disaggregated approach is used, the steps will have to be carried out individually for each data group. It is also possible for the user to lump two categories together, e.g., commercial and industrial. In this case, the steps will have to be carried out twice, once for each data group.

Those users with very little time or data may substitute a simpler approach for calculating assessed valuation. Instead of analyzing real growth and inflationary growth separately, they may simply extrapolate historical assessed valuation totals, using the linear (Type A) or nonlinear (Type B or C) curves described below.

4.5.1.2 Community Development Analysis

The initial task in forecasting assessed valuation is to identify a trend or curve which is believed most likely to reflect the future pattern of land development in the school district. In order to specify a curve, the user must decide (a) whether the community is growing, remaining stable, or declining, and (b) whether these trends can be expected to continue throughout the planning period in light of the present and expected economic conditions. Trends in interest rates, availability of credit, unemployment, labor force, and similar factors should be considered, if possible, in consultation with business and economic analysts in the community.

In the Enrollment Component, Section 2.2.2, "Time Trend Projections," three curves have been described and the steps necessary for their computation presented. If the user has not already done so, this section should be read. These curves will be used to project land development. Of the curves described, one is linear and two are nonlinear. Use of a linear curve, whether for growth or decline, implies that the rate of change will remain constant. While this may be a valid assumption where the rate of change is gradual, it should be kept in mind that there are limits to both growth and decline within a community. In the case of a growing community the actual amount of land available for development as defined by physical space, zoning restrictions, water and sewage supply, transportation, etc. represents an upper limit to growth. In the case of a declining community the demolition or vacancy of buildings will not continue indefinitely without an equally drastic decrease in population. The user is cautioned to apply the linear curve only in those cases where the community is relatively stable, with growth or decline taking place only gradually, or where a very short planning horizon has been selected.

Two nonlinear curves are presented, the first representing growth and the second representing decline. Both are logistic curves. In most cases, the nonlinear curves should be used as they require the user to specify an upper limit to growth or a lower limit to decline. These limits represent the "practical" maximum amount of growth or decline a community could achieve, given its physical, social, and economic characteristics. The pattern of growth exhibited by the logistic curve is one in which development progresses through a period of rapid growth, diminishes and eventually becomes negligible as the upper limit is approached. As explained in the Enrollment Component, because communities may be in different phases of development, the historical data may not appear to follow a logistics growth pattern. However, the curve will often remain applicable

Nonlinear decline patterns may be estimated with an inverted logistic curve. The curve is based on the assumption that the demolition or vacancy of existing property will not continue forever and that the rate of decrease will diminish as a lower limit is approached. As with the nonlinear growth curve, in some cases the historical trend may not appear to follow the inverted logistics decline pattern, but the curve may still be useful.

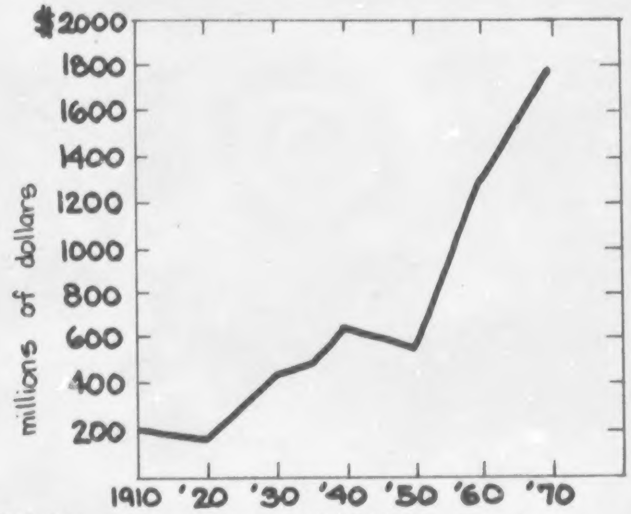
Before selecting a curve, the user should graph the historical data and compare the graph with the various figures presented in Chapter 2. This procedure will assist in selecting a curve by providing a visual comparison between previous trends and potential future trends.

Once an initial selection has been made, the impact of future economic conditions should be considered. This consideration should be done with particular care in cases where development is expected. Factors to be examined should include: (a) interest rates on loans, (b) availability of loans, (c) construction costs and the impact of inflation on these costs, and (d) sources of employment in the area. An increase in factors (a) or (c), and/or a decrease in (b) or (d) will have a negative effect on future growth. Consideration of zoning restrictions, and the availability of transportation and utilities must also be made. Often rezoning an area for development or extending a utility line will initiate or accelerate growth. Once all factors have been considered, a final selection of a curve is made, an upper or lower limit to growth or decline is specified, and the necessary historical data is collected.

4.5.1.3 Assessed Valuation and Tax Yield

After the number of dwellings and the amount of commercial and industrial activity have been projected, an estimated value must be determined. The assessed valuation is usually calculated as a percentage of the true value of real property. However, in many communities the recalculations necessary to reflect changes in the value of land and improvements are made infrequently. Therefore the projections involve several considerations. The average assessed valuation associated with a new structure or a demolished structure is calculated. When multiplied times a projection of the total new or demolished units, the addition or loss to the tax base is calculated. Second, procedures are provided so that the impact of the municipal or county reassessment policy can be determined.

The theoretical tax yield is calculated by mutliplying the assessed valuation forecast times the tax rate. In communities where tax delinquency is a problem, this potential yield may be multiplied times a collection rate to determine a more realistic yield.



* listed in St. Louis County School Reports using constant dollars (1957-59 = 100)

ASSESSED VALUATION INCREASE*
ST. LOUIS COUNTY

4.5.1.4 LOCAL PROPERTY TAX FORECASTING PROCEDURES

Forecasts of local property tax revenue require several activities: the projection of community growth or decline, the projection of assessed valuation, and the application of a tax rate. Procedures for carrying out these activities are organized into two tasks.

Task I: Community Development Projections. The procedures for projecting community growth or decline have been explained in Section 2.2.2.3. Form I.1 is recommended for projecting linear growth or decline, Form I.2 is recommended for the nonlinear growth situation and Form I.3 is recommended for the nonlinear declining situation. Instructions are presented for those steps that differ from the specific procedures described in Chapter 2.

Forecasts made with the three curve extrapolation techniques will require the collection of historical data. Most projections of development will be made in terms of structures; however, acres of land or square feet of building space can be used as an alternative basis for analysis. The procedures are presented for a community examining the probable increase or decrease in structures. If a disaggregate approach is selected, individual totals for residential, commercial, and industrial land use categories are needed. If two categories are grouped together, two totals are needed; and if the gross data approach is used, only one total will be needed. Historical numbers of structures may be difficult to obtain, particularly if the school district boundaries do not coincide with those of any other local jurisdictions. Building permits may suffice as a proxy for the actual number of units. These are generally available from the local government. In some cases, the use of aerial photography for past years may be appropriate.

Once the user has selected the number of land use categories to be examined and the appropriate curve, the steps described below must be carried out. If desired, a separate curve could be selected for each land use type.

Type A Communities—Linear Growth or Decline. Form I.1 is used to forecast land development if a linear curve has been selected.

Step 1. Select the appropriate number of historical observations to be used. This selection will depend upon the number of years for which a linear trend has been discernible. For example, if development of most residential units has taken place only in the last five years, compared with very limited growth in the previous years, then only the last five years would be used. Enter historical and future years on Line 1.

Step 2. Complete Steps 1 through 6 as described in Chapter 2, Section 2.2.2.3, Curve Type A. The lines on Form I.1 correspond to those indicated in the Curve Type A steps. The only substitution necessary is in Step 7. Here, the total number of structures (acres or square feet) of the type being forecast must be substituted for enrollment on Line 7.

Step 3. All remaining steps are then completed. Line 17 will contain the actual projections. The values through Column 10 will provide an indication of how closely the fitted curve approximates the actual values. The values in the remaining columns represent the forecasts. If the user feels the forecast values are not correct, it is suggested that a nonlinear curve be considered.

An example of a school district's projected development is presented on Form I.1 at the back of the report. Residential growth has been forecast in terms of future dwelling units, using ten years of historical data. Based on the assumption of linear growth, the district is projected to grow from its 1974 size of 2,658 to more than 5000 units in 1984.

Type B Communities—Nonlinear Growth. Form I.2 will be used to forecast development if a nonlinear growth curve is used.

Step 1. Select the approximate number of historical observations to be used in the calculations. It is suggested that between five and ten years of historical data be used. If, however, some substantial period of decline in development occurred at the beginning of any span of observations, the data for these years should not be used. The lines on Form I.2 correspond to those described in the steps for Curve Type B, Section 2.2.2.3, Chapter 2.

Step 2. Complete Steps 1 through 6 as described in Chapter 2.

Step 3. Complete Step 7 as described in Chapter 2; however, substitute data on the number of structures for enrollment on Line 7.

Step 4. Enter on Line 8 the estimated upper limit of structures to be developed in the community, given its estimated holding capacity and probable future growth.

Step 5. Complete Steps 9 through 24; Lines 1 through 24 should now be completed. Line 24 will contain the estimated number of structures projected to exist in each year of the planning period.

An example of a school district's projected development using this approach is presented on Form I.2. Residential growth has been forecast in terms of future dwelling units, using five years of historical data. Based on the assumption of a nonlinear growth pattern, this district is projected to grow from 2200 units in 1974 to almost 2400 in 1984.

Type C Communities—Nonlinear Decline. Form I.3 is used to forecast development when a nonlinear decline in the number of structures is expected. The lines in Form I.3 will correspond to those described in the steps in Chapter 2, Section 2.2.2.3, Curve Type C.

Step 1. Select the appropriate number of historical observations for use in the calculations. If any growth occurred during the beginning of the historical period, data for these years should not be included.

Step 2. Complete Steps 1 through 6 and Lines 1 through 6 as indicated in Chapter 2.

Step 3. In Step 7, substitute data on the number of structures for enrollment on Line 7.

Step 4. In Step 8, enter the estimated lower limit for the number of structures in the community on Line 8.

Step 5. Complete Steps 9 through 28. Line 28 will contain the actual number of structures projected to exist in each year of the planning period.

An example of a district's projected decline is presented on Form I.3. Residential decline has been forecast in terms of future units, using seven years of historical data. Based on the assumption of nonlinear decline that would approach a limit of 3000 units, the district is expected to have approximately 3100 units in 1984, compared with 4500 in 1974 and 6000 in 1968.

Task II: Assessed Valuation/Tax Revenue Forecasting Procedures. After the number of structures, acres, or square feet have been projected for each year of the planning period, the user must calculate the projected assessed valuation and tax yield. Form J will be used. If more than one category of land was analyzed, the following steps must be completed for each type. The district's total assessed valuation will equal the sum of the individual land type assessed valuations. Required input data includes historical assessed valuation information, historical numbers of new and demolished units, expected inflation rates, expected local government reassessment policy, and the expected tax and tax collection rate.

Step 1. Line 1 contains the years, with the current year in Column 10. Enter the historical data used to project the number of structures (acres, or square feet) and the projections on Line 2. If less than ten years of past data are used, then some of the columns on the left should be blank. For example, if only four years of historical data are used, Columns 1 through 5 will be left blank. Enter historical assessed valuation data for the same years on Line 3. If residential property is being considered, then only the assessed valuation for residential structures should be recorded. If commercial or industrial acres or square feet are being analyzed, commercial or industrial assessed valuation is recorded.

Step 2. Calculate the annual incremental change on Line 2. Enter these figures on Line 4. These figures represent the net increase or decrease in structures (acres or square feet) that has occurred in the past and is expected in the future.

In most communities the numbers on Line 2 will be positive reflecting actual or projected new units. A few communities will be characterized predominantly by demolition or abandonment, with very few new units expected. In these cases the values on Line 2 will be negative. Still other communities may be characterized by significant amounts of construction and demolition activity concurrently. Each situation demands a different set of steps as outlined in the following options.

1. Predominant Decline. If major decline is projected in the community with little or no new construction expected, Steps 3 and 4 must be completed, and values entered for Lines 5 and 6. Steps 5 through 14 will not be completed, thereby leaving Lines 7 through 17 blank. This will produce a projection of assessed valuation decrease because of the demolition of structures.

2. Predominant Growth. If community growth is anticipated and little or no demolition Steps 3 and 4 are not necessary. Steps 5 through 14 must be carried out, and values entered on Lines 7 through 17. This will yield a projection of assessed valuation increase because of the construction of new structures.

3. Mixed Construction and Demolition. If both construction and demolition activity are anticipated, all steps should be carried out. This will produce independent projections of the loss in tax base because of demolition and the growth in tax base because of new construction. The difference is the net tax base change attributable to changes in total structures.

Step 3. Estimate the average assessed value of structures to be demolished in the coming years. Enter this figure in all columns of the planning period on Line 5. The estimate may be determined from an inspection of assessor records, and/or conversation with municipal or county building permit officials. In most cases, the figure should be less than the average assessed value per unit for the total community (Line 3 divided by Line 2). In situations where the user has reason to believe that the average value of structures to be demolished will increase (because of general inflation or demolition activity in a particular neighborhood) or decrease (because of reappraisal), adjustments can be made in the appropriate columns.

If the change in assessed value contributed by both demolition and construction is to be examined (Option 3), the number of structures to be demolished must be estimated. In certain instances this might be projected, using a Type A Curve; however, an estimate based on review of past demolition activity and future local government policy is likely to be more accurate. This projection should be recorded as a negative figure on Line 6 starting with Column 11. Notice that the sum of expected demolitions (Line 6) and construction (Line 8) must equal the net change in structures (Line 4).

Step 4. Multiply the average assessed valuation of structures to be demolished on Line 5 by the number of structures estimated to be demolished. If Option 1 has been selected, these values are found on Line 4, starting in Column 11 and continuing throughout the planning period. If Option 3 has been selected, these values are found in the same columns on Line 6. Enter the product on Line 7, in the appropriate years of the planning period. These figures represent the amount of assessed valuation expected to be subtracted from the tax base because of demolition. The numbers should be negative. Users who have selected Option 1 should now proceed to Step 15.

Step 5. Estimate the annual number of new structures built in recent years and expected during the planning period. If little or no demolition activity is anticipated (Option 2), this estimate will already exist. The structures referenced on Line 4 can all be assumed to be new structures. If significant demolition and construction is expected (Option 3), estimates of new construction must be prepared. The projections must equal the difference between the projected net change in structures (Line 4) and demolition(Line 5). Enter these new figures on Line 8.

Step 6. Enter historical data on assessed valuation for new structures on Line 9. If there have been no reappraisal of existing structures and no demolition this amount will constitute the difference between two successive years on Line 3.

Step 7. Divide the values in the historical and current year columns on Line 9 by the values on Line 4 (if Option 2 is selected) or Line 8 (if Option 3 is selected). Enter the results in the corresponding columns of Line 10. These figures represent the average assessed valuation of new structures built in each year of the historical period.

If the data necessary to complete Line 9 is not readily available, the user may select a random sample of new structures built in each year and divide their combined assessed value by the sample size to obtain an average value. These figures are entered on Line 10.

Step 8. Calculate the annual incremental change of the values on Line 10. Enter these figures on Line 11. These figures are the yearly increase in average assessed valuation for new structures.

Step 9. Determine the annual percentage increase in average assessed valuation for new structures by dividing the values on Line 11, year t, by the values for the previous year, t-1, on Line 10. Enter the results on Line 12.

Step 10. Project the rate at which the average value of new structures will grow in the future. Given the rapid inflation in construction in recent years, this figure will be difficult to estimate. One approach is to select the most recent rate of increase, which is contained in Column 10 Line 12. A second approach is to calculate an average, using several years of historical data. Some users may want to extrapolate the rate of increase, or perhaps use the same percentage rates assumed in the building cost index projections (Lines 3 3a, 3b, Form E). Whatever rates are selected should have one (1) added to them and should be entered on Line 13 in the appropriate columns of the planning period. The first entry must be placed in Column 11.

Step 11. Enter consecutive numbers on Line 14, starting with a one (1) in Column 11 and continuing through that column which represents the year of the planning horizon.

Step 12. If the same growth rate has been projected to apply in each year of the planning period, raise each entry on Line 13 to the power indicated by the number in the corresponding column on Line 14. For example, the value in Column 11 will be raised to the first power; the value in Column 12 to the second power, etc. Enter these figures on Line 15.

Step 13. If the same growth rate has been used throughout the planning period, multiply the entry in Column 10 of Line 10 times each entry on Line 15. The resulting projections of average assessed valuation for new structures should be entered on Line 16.

If different growth rates have been selected for separate years of the planning period, they must be applied individually against the average assessed valuation for new structures in the previous year. For example, the estimated percentage increase in Column 11, Line 13 would be multiplied times the current average assessed valuation per new structure in Column 10, Line 10. The resulting product would then be multiplied times the rate in Column 12, Line 13, etc. Enter all projected figures on Line 16.

Step 14. Multiply the entries on Line 16 by the expected number of new structures for corresponding years. These figures are recorded in Columns 11 through the planning period of Line 4 (if Option 2 is selected) or Line 8 (if Option 3 is selected). Enter the products on Line 17. These figures represent the increase in school district assessed valuation for each year of the planning period because of the construction of new structures.

Step 15. Calculate the net change in assessed valuation because of construction and/or demolition activity by subtracting the values on Line 7 from the values on Line 17. Enter the results on Line 18. If Option 1 or 2 was selected, there will be no change because either Line 7 or Line 17 will contain blanks. If Option 3 was selected, a new net change to the tax base, in light of both expected demolition and construction, will be calculated.

The remaining steps focus on changes in the assessed valuation of existing structures because of reassessment, and on the application of a tax rate.

Step 16. Select a random sample of structures which have been in existence throughout the historical period. Enter their total assessed valuation on Line 19 for each historical year.

Step 17. Divide each entry on Line 19 by the entry in the preceding column of that line. For example, if ten years of historical data have been used, the entry in Column 2 will be divided by the entry in Column 1; the entry in Column 3 will be divided by that in 2; etc. Enter these totals on Line 20.

Step 18. Subtract one (1) from each entry on Line 20 and place the new number on Line 21. These figures represent the percentage increase in the assessed valuation of existing structures. No specific method for projecting this rate will apply in all communities; each district must select that which appears most appropriate. If land is reassessed on a regular yearly basis, the projected rate of increase should correspond roughly to the inflation rate expected for existing residential, commercial, or industrial space. The percentage increase used to project the building cost index may provide a useful guide. If property is not reassessed annually, the projection will depend upon the user's expectation as to how often the property will be reassessed, keeping in mind the rate of inflation. The projected figures are entered on Line 21 for each year of the planning period.

Step 19. The final computations needed to project assessed valuation cannot be made with Form J. The user must calculate each total individually and then enter the amount in the proper column of Line 3. The same equations will be used to compute total assessed valuation for declining (Option 1), growing (Option 2), and mixed (Option 3) communities.

$$AV_t = AV_{t-1} \quad (X_t) + AV_{t-1} + \Delta AV_t$$

where AV_t equals assessed valuation in year t.
t equals 1, 2,...., n and corresponds to each year of the planning period.

AV_{t-1} equals the assessed valuation in year t-1.
X_t equals the percentage increase in the assessed value of existing property in year t (Line 18).
$\triangle AV_t$ equals the increase in assessed value because of new and/or demolished structures (Line 15).

This equation can be formulated and carried out in the following manner:

$$AV_t = AV_{t-1}\ (1 + X_t) + \triangle AV_t$$

$$\begin{array}{llllll} \text{Column 11} & = & \text{Col. 10} & (1 + \text{Col. 11}) & + & \text{Col. 11,} \\ \text{Line 3} & & \text{Line 3} & \text{Line 21} & & \text{Line 18} \end{array}$$

$$\begin{array}{llllll} \text{Column 12} & = & \text{Col. 11} & (1 + \text{Col. 12}) & + & \text{Col. 12, etc.} \\ \text{Line 3} & & \text{Line 3} & \text{Line 21} & & \text{Line 18} \end{array}$$

For example, in a school district with an existing assessed valuation of $17,143,000, which was expected to increase annually by three percent, and with an anticipated increase of $903,300 resulting from new construction, the new assessed valuation would be determined and rounded as follows:

$$\begin{aligned} AV_t &= 17{,}143{,}000\ (1 + .03) + 903{,}300 \\ &= 17{,}657{,}290 + 903{,}300 \\ &= 18{,}560{,}590 \\ &= 18{,}561{,}000 \end{aligned}$$

Alternatively, in a district where the change in assessed valuation of existing structures was expected to be + .015 annually (Column 11, Line 21), the current assessed valuation was $106,500,000 (Column 10, Line 3), and the net change in assessed valuation because of demolition and construction activity (Column 11, Line 18) was expected to be a loss of $1,500 000 in the coming year, the calculations would be carried out as follows:

$$\begin{aligned} AV_t &= 106{,}500{,}000\ (1 + .015) + (-1{,}500{,}000) \\ &= 108{,}097{,}500 - 1{,}500{,}000 \\ &= 106{,}597{,}500 \\ &= 106{,}598{,}000 \end{aligned}$$

Again the process is repeated until Line 3 is completed for all years of the planning horizon. With the completion of assessed valuation forecasts, tax revenue may be estimated.

Step 20. Enter the property tax rate for each year of the planning period on Line 22. The current tax rate may be entered for the entire planning period, or the user may enter an assumed value based on an expected increase or decrease in the rate.

Step 21. Multiply Line 22 times Line 3, and enter the results on Line 23. This will yield projections of the taxes to be levied on real property for each year of the planning period. If there is a significant difference between taxes levied and taxes collected, the actual collection rate may be calculated and entered in Columns 1 to 10 of Line 24. This rate is determined by dividing the taxes levied during the past several years by the amount actually collected. The future rate should then be estimated, entered in the remaining columns of Line 4, and multiplied by each entry on Line 23. This procedure will yield an estimate of actual property tax revenue which the district is expected to receive. Enter these figures on Line 25.

Finally the projections should be transferred to Summary Form B. Enter the values on Line 3 of Form J to Line 201 of Summary Form B; the values on Line 22 to Line 202 of Summary Form B and the values on Line 25 (or Line 23) to Line 203 of Summary Form B.

In the final section of this component, procedures are offered for creating a fiscal plan based on a comparison of estimated expenditures and revenues. As part of this analysis, the district may want to examine the impact of an increase or decrease in the tax rate. In these cases, the entries on Line 202 of the Summary Form B will have to be changed and Line 203 recalculated.

4.5.1.5 Other Local Revenue

Local school district revenue may also be generated from other taxes and/or from non-tax sources. Additional tax revenue might be derived from sales, income, and a variety of miscellaneous local taxes. Non-tax revenue typically derives from specific school programs such as tuition, transportation fees, interest on investments, food service, and pupil activities.

In situations where this additional revenue is relatively small, and historically appears to be about the same percentage of the total local revenue, a ratio may be used. This ratio of local property tax revenue to total school district revenue should be calculated for previous years. An average or projected ratio should then be applied against the projected property tax revenue for future years.

Some districts will want to analyze other tax revenue separately from non-tax revenue and to project each category independently. Suggested ideas for conducting such analysis are outlined below. However, because each district will have a unique fiscal setting, it is not possible to present comprehensive procedures for all situations. Consideration of alternative techniques is encouraged. In general, it is recommended that most of the revenue categories be projected as a function of some other variable, such as dwelling units or enrollment that has already been forecast. Linear regression methods are recommended. Some users may want to experiment with exponential regression, as used in Form G, to better account for inflation.

In most communities revenue from a sales or merchants tax will correlate with the number and size of retail sales outlets in the district, or more specifically, with the number of square feet of retail floor space. Income tax revenues will usually be related to the number of dwelling units or business units, depending upon whether it is a personal income tax, or a corporate or business tax. In the preceding section, future commercial and residentia development was estimated. Therefore, sales or income tax revenue may be projected as a function of one of these variables. If a corporate, business, or sales tax is a source of revenue for the school system and only total property development was forecast, this figure may be used as a surrogate variable.

PROCEDURES FOR FORM K.

4.5.1.6 OTHER LOCAL TAX REVENUE FORECASTING PROCEDURES

To project local sales or income tax revenue, the linear extrapolation method, Curve Type A, will be used as presented in Section 2.2.2.3 of the Enrollment Component. In each case, the tax revenue to be projected is the dependent variable, and it replaces enrollment in the instructions. The number of dwelling units, business units, space or land are the independent variables, replacing time in the instructions. Form K presents an example of how one of these tax categories might be estimated. Sales tax revenue is the dependent variable to be projected. The number of commercial structures is the independent variable. As such, both historical and projected numbers of commercial structures must be available. The lines on Form K correspond to those described in the steps in Chapter 2.

Step 1. Complete Line 1 of Form K as indicated in Step 1 in the Enrollment Component. In Step 2 substitute historical and projected data on the number of commercial units for the number of years.

Step 2. Complete Steps 3 through 6 as indicated.

Step 3. Substitute historical data on sales taxes, in place of enrollment, in Step 7 and enter these figures on Line 7.

Step 4. Complete Steps 8 through 17. Line 17 will contain projections of sales tax revenue for each year of the planning period.

Tax revenues which are based on property and/or income values will increase or decrease as a function of either an increase or decrease in the amount of property and/or income in the district; or an increase or decrease in inflation. The method outlined above projects increases or decreases in tax revenues only as a function of changes in property. Thus, if it is believed that the projections of the tax revenues are too low, the user may adjust them upward based on expectations of future rates of inflation. If more than one kind of local tax exists, in addition to the property tax then several projections will be necessary, using Form K. In each case, the independent variables selected for use in the projection must be (a) available for the historical and projected planning period, and (b) directly or indirectly related to the tax being projected. Revenue from all other local taxes is entered on Line 204 of Summary Form B. Total tax revenue from local sources is the sum of Lines 203 and 204. This total is entered on Line 205 of Summary Form B.

PROCEDURES FOR FORM L & M.

4.5.1.7 NON-TAX REVENUE FORECASTING PROCEDURES

The diversity of internal sources of revenue within school systems complicates the identification of standard forecasting procedures. As with local taxes other than the property tax, the user is encouraged to develop techniques that fit the unique district situation. Several possible approaches are outlined below:

Revenue From Tuition. Tuition varies substantially as an important source of revenue. Public school tuition payments are a function of the number of students attending schools within the district yet residing outside its geographic boundaries. No specific method of projecting tuition can be provided here. The user should estimate the number of students outside the district's jurisdiction that are expected to attend schools within the system, the board's policy regarding such attendance, and the probability of increased tuition in future years.

Revenue From Students. A variety of revenue sources will be directly related to the number and preferences of students. These include food service payments, transportation fees, activity fees, and other miscellaneous charges. The easiest forecasting approach is to determine historically what percent of the student body has participated in the program, and what the average contribution per student has been. Estimates can then be made as to the expected percent of students likely to participate in the future and the expected average charge per student. Multiplying these two figures by the number of expected future students, as projected in the Enrollment Component, provides a revenue forecast.

Linear forecasts may be accomplished for these categories, using the Curve Type A regression. In this case revenue in a given category is the dependent variable, and enrollment the independent variable. Form L provides an example of how selected activity fees might be projected. As with the other Curve Type A forecasts, the lines on Form L correspond to the steps described in Section 2.2.2.3 of Chapter 2.

Step 1. Complete Line 1 of Form L as indicated in Step 1 in the Enrollment Component. In Step 2, substitute historical and projected enrollment for the number of years.

Step 2. Complete Steps 3 through 6 as indicated.

Step 3. Enter historical data on pupil activity fees, in place of enrollment, in Step 7. Place these figures on Line 7.

Step 4. Complete Steps 8 through 17 as indicated. Line 17 will contain the projection of activity fees for each year of the planning period.

These revenue projections will be made on the basis of enrollment and will not account for the impact of inflation. If the user believes that the projections are biased downward, they may be adjusted accordingly, based on expectations about future rates of inflation.

Interest on Investments. A final source of revenues for consideration is the interest on investments. Earnings on investments are a function of the time-lag between the receipt of revenues and the payment of expenses. They are also influenced by the rate of interest being paid on short-term investments. Earnings from long-term investments could also contribute to this category, but will not be applicable to most districts. It is recommended that earnings on investments be projected as a function of total local taxes received. Form M is used to record these calculations.

Step 1. Line 1 contains the years, with the current year in Column 10. Enter historical and projected data on total local tax revenues received in the corresponding columns of Line 2. This information is on Line 205 of Summary Form B. Enter historical data on earnings on investments on Line 3.

Step 2. Divide Line 3 by Line 2 and enter these totals on Line 4.

Step 3. Select an earning-as-a-percent-of-taxes figure expected in future years. This may be achieved by computing the arithmetic average of Line 4. Enter this figure in Column 1 of Line 5. Alternatively, the most recent year value may be used (Line 4, Column 10), or the historical figures may be projected.

Step 4. Multiply the entries on Line 2 corresponding to the planning period, Column 11 on, by the entry on Line 5. Record these totals on Line 6. The totals represent projections of earnings on investments for the planning period.

This method for projecting earnings on investments assumes that a relatively constant percentage of total tax revenue is invested each year. If the percentage is not constant, the user must decide what factors contribute to the fluctuations. Movements in short-term interest rates may be an important consideration; however, these are difficult to predict. Where this is believed to be the only cause of fluctuation, consultation with local authorities might be appropriate to determine the extent to which rates are expected to continue to increase. If, however, the change is the result of other policy variables, the user should again consider what the trend will be in the future and complete Line 5 of Form L on the basis of this judgement.

Other local district revenues are subject to such broad definition and variations that they can only be estimated on the basis of the user's knowledge and judgement. Again, earlier decisions regarding expected rates of inflation and community development should be kept in mind while making these decisions.

All revenue from the above and other non-tax sources which may apply to a specific school district should be totaled and entered on Line 206 of Summary Form B.

4.5.1.8 Intermediate Sources of Revenue

There are two general cases in which a school system may receive revenue from intermediate sources. The first is the situation in which the district is not a legal taxing entity and derives all of its local revenues from a city or county which supports the district out of general revenue funds. In this case, the city or county's general revenue will have to be forecast, and the school system's share will be computed as a percentage of the total general revenue.

In the second case, the school system is a legal taxing entity that receives some of its revenue from the intermediate source, either because of local legislation or because the system has delegated the tax collection function. In this situation the collection/distribution function may be strictly a pass-through, or the intermediate source may exercise some discretion in the allocation of collected funds.

If either case exists in the school system, the user must obtain a forecast of intermediate revenues for each year of the planning period. These totals are entered on Line 209 of Summary Form B.

To obtain total local revenues from all sources, Lines 205, 206, and 209 are summed, and the totals are entered on Line 210 of Summary Form B.

4.5.2 State and Federal Revenue

The school district's local revenue is increasingly being supplemented by assistance from the state and federal government. This results from the ability of higher levels of government to raise tax monies more easily and redistribute monies on the basis of need. While many kinds of state aid exist, most programs can be grouped into one of four major categories discussed in this section: (1) unrestricted grants-in-aid, (2) restricted grants-in-aid, (3) revenue in lieu of taxes, and (4) revenues for or on behalf of the school system. Federal aid is usually so small as not to warrant subdivision into separate categories as part of this analysis.

Unrestricted Grants-in-Aid. Unrestricted grants-in-aid are the primary source of revenues from the states. In recent years this category has constituted a considerable portion of the school system's revenues. Approximately thirty-one percent of total school revenues came from unrestricted grants-in-aid provided by the states in 1971-72. These unrestricted grants-in-aid are made by using one or more of five basic techniques for distributing funds. As defined by the National Education Finance Project, the techniques include: Flat Grants, Strayer—Haig—Mort, Percentage Equalization, Guaranteed Valuation on Tax Yield, and Complete State and Federal Support. Within each of these techniques there are so many variations that it would be impossible to create a precise formula which could explicitly include all the variables. Also, in most cases a large amount of uncertainty characterizes the activities of the typical state legislature in regard to state aid. In view of this complexity, two methods of forecasting state aid are presented. The first uses total enrollment as the independent variable, and the second uses assessed valuation per student as the independent variable. In both cases, the steps outlined in Section 2.2.2.3 of Chapter 2, Curve Type A, are used to make a linear projection. If neither method appears to provide a useful forecast because of the particular formula governing the state aid program, the user is encouraged to devise a new technique.

Restricted Grants-in-Aid. Restricted grants-in-aid at the state level include several categories of special purpose programs such as Special or Exceptional Education Grants, Vocational Education Grants, Transportation Grants, School Housing Grants, Textbook, Library Equipment and Supply Grants, Driver Education Grants, and School Lunch Grants. Individual school systems may or may not qualify for these programs, and even when they do some may elect not to participate. Similarly no standard projection techniques can be prescribed for all situations. Users must forecast restricted grant monies based on knowledge of state programs, past associations, and the district's ability and desire to qualify.

Revenue in Lieu of Taxes. Revenue in lieu of taxes is available from some states to compensate for the fact that the state may own or control property within the school district on which Ad Valorem taxes are not paid. Revenues of this nature are relatively constant except for variations in the amount of property owned by the state, and variations in local reassessment policy Forecasts must be made based on knowledge of the state legislation and existing state holdings within the district.

Revenues for or on Behalf of the School System. Revenues for or on behalf of the school system include any revenue collected by the state on behalf of the system and "passes through" without redistribution Thus some portion of the state sale or income tax that is collected in the district may automatically be returned to it. Forecasts in this case would be similar to those procedures used in Section 4.5.1.6 to determine other local tax revenue.

Federal Revenue. On the federal level, the revenue categories are the same as on the state level. However, unrestricted grants-in-aid at the federal level are not a significant source of revenue, and the distinction between restricted and unrestricted grants-in-aid is mainly for accounting purposes. Since in most districts the revenue from federal sources represents such a small percentage of total school system revenues, there will usually be no need for such a detailed breakdown.

In some districts the amount of federal aid will be so small, or so variable, as to be hardly worth projecting. In this situation, the user may want to estimate an overall amount, using personal judgement. For those districts that choose to project federal revenue on a more rigorous basis, a technique is presented which makes the assumption that federal revenue per pupil will not change substantially as a percent of cost per pupil from its historical pattern. Therefore, to determine future federal revenues, federal revenue per pupil as a percentage of cost per pupil is projected. This percentage is then multiplied times the projected cost per pupil to obtain revenue per pupil. In turn, it is multiplied by projected total enrollment to obtain total federal aid. All the calculations are recorded on Form P. This technique will not be appropriate for all districts. Users are encouraged to substitute their own method once they determine that forecasting federal revenue in their district is worthwhile.

4.5.2.1 STATE REVENUE FORECASTING PROCEDURES

Techniques for projecting state aid must be tailored to the particular legislative programs that apply The procedures outlined below should be considered initial approaches to be refined in light of the school district's unique setting.

State Aid as a Function of Enrollment: Form N. In many cases state aid is awarded on a per student basis, using either enrollment or average daily attendance. In some instances, it may be awarded on a per teacher basis, in which case, historical and projected data on the number of teachers should be substituted for enrollment. Form N is used to project state aid as a function of enrollment. Its lines correspond to those described for Curve Type A in Section 2.2.2.3, Chapter 2.

Step 1. Line 1 contains the years, with the current year in Column 10. Enter historical and projected enrollment figures on Line 2.

Step 2. Complete Steps 3 through 6 as indicated in the Enrollment Component, completing Lines 3 through 6, Columns 1 through 10.

Step 3. Enter historical data on state aid, in place of enrollment, in Step 7, Line 7.

Step 4. Complete Steps 8 through 17. Line 17 contains projections of total state aid in unrestricted grants-in-aid for the school system for each year of the planning period. The projections should be transferred to Line 215 on Summary Form B.

State Aid as a Function of Assessed Valuation: Form O. The second method for projecting state aid uses state aid per student as the dependent variable and assessed valuation per student as the independent variable. The projections of state aid per student are then multiplied times enrollment projections to obtain total state aid.

The rationale behind projecting state aid as a function of assessed valuation per student derives from the fact that many states are taking steps to equalize the quality of education. This process often involves providing more support for poorer districts, where the relative wealth of a district is measured in terms of its assessed valuation per student. Form O will be used to make the projections. The method is again a linear extrapolation using Curve Type A. Additional lines must be added, e.g., 1a - 1d and 18, for which there are not corresponding steps in Chapter 2. These additional steps are listed below. All other lines correspond to those described in Chapter 2.

Step 1. Line 1 contains the years, with the current year in Column 10 Enter historical and projected enrollment on Line 1a. Enter historical and projected total assessed valuation on Line 1b. These figures may be obtained from Line 201 of Summary Form B. Enter historical data on unrestricted grants-in-aid on Line 1c.

Step 2. Divide Line 1c by Line 1a. Enter the resulting state aid per student figures on Line 1d.

Step 3. Divide Line 1b by Line 1a. Enter the resulting assessed valuation per student figures on Line 2.

Step 4. Complete Steps 3 through 6 as indicated in the Enrollment Component. Enter the results on Lines 3 through 6 on Form O.

Step 5. Move the state aid per student figures from Line 1d to Line 7, in place of enrollment, in Step 7.

Step 6. Complete Steps 8 through 13.

Step 7. Move the assessed valuation per student figures from Line 2 to Line 14.

Step 8. Complete Steps 15 through 17. Line 17 contains the projection of unrestricted grants-in-aid per student.

Step 9. Multiply Line 17 by Line 1a. Enter these figures on Line 18. These figures constitute projections of total unrestricted grants-in-aid to the district for each year of the planning period. Transfer the projection of unrestricted grants-in-aid to Line 215 of Summary Form B.

Neither of the two methods for projecting unrestricted state aid specifically account for the uncertainty associated with state legislation. The user is cautioned to view these projections with only the amount of certainty one has in the activities of the state legislature. If during the planning period the formula for distributing unrestricted grants-in-aid changes, these figures should be recalculated.

Restricted State Grants-in-Aid. If the district participates in various restricted aid programs, those variables used in making the allocations should be identified and projected. In most cases, enrollment, assessed valuations, or teachers forecasts which have already been made may be used as the independent variables in a Curve Type A linear regression. In some cases a simple extrapolation of historical values may provide reasonable forecasts. In such instances Curve Type A could again be used with time as the independent variable (See Form I1). All projected revenue in the restricted grant-in-aid category should be placed on Line 216 on Summary Form B.

Revenue in Lieu of Taxes. If the state pays revenue in lieu of taxes, calculate the assessed valuation of all land involved and the rate of compensation. Enter the anticipated revenue from this source on Line 217 of Summary Form B where appropriate.

Revenue for or on Behalf of the School System. If the state contributes a portion of the taxes it collects within the district, project the expected tax revenue. The procedures outlined in Section 4.5.1 6 for calculating other local tax revenue may be followed. The fraction of state tax revenue expected to be returned to the district should be entered on Line 218 of Summary Form B.

After completing the projections of all revenue from the state, record them on Summary Form B, Lines 215 through 218. Enter the sum of Lines 215 through 218 on Line 220.

PROCEDURES FOR FORM P.

4.5.2.2 FEDERAL REVENUE FORECASTING PROCEDURES

If federal revenue is received by the district, the user should identify the specific programs and the allocation formula, if any, used. Projections by program category should then be made based on judgement as to the program's continuation and the district's interest and ability to qualify.

Those districts interested in a general forecasting technique may consider the method presented on Form P. This approach rests on the assumption that federal revenues to the district will continue to cover the same percentage of cost in future years as they have in the past. Thus, federal revenues are forecast to vary in proportion to local costs.

Data requirements include historical and projected figures for district enrollments and costs, and the amount of federal revenue received by the district in past years.

Step 1. Planning Horizon. Line 1 should designate years with the current year period entered in Column 10 and years for which projections are to be made entered in Columns 11 throughout the planning period.

Step 2. Enrollment. Enter historical and projected data on total school enrollment on Line 2.

Step 3. Total Cost Information. Enter historical and projected data on operating costs on Line 3. This data will have been previously calculated and entered on Line 10[illegible] of Summary Form A.

Step 4. Previous Federal Assistance. Enter the amount of total federal revenues received over the past years on Line 4.

Step 5. Average Costs per Student. Divide Line 3 by Line 2. Enter the resulting average cost per student on Line 5.

Step 6. Average Federal Revenue per Student. Divide Line 4 by Line 2. Enter the resulting average federal revenue per student on Line 6.

Step 7. Federal Revenue per Student as a Percent of Student Cost. Divide Line 6 by Line 5. Enter these figures on Line 7. These entries represent revenue per student as a percentage of cost per student. Line 7 can now be projected by entering the average historical value, or the value calculated in Column 10, to each of the subsequent columns corresponding to years in the planning period. In some districts, extrapolation of the percentage may be appropriate if it has demonstrated a clear upward or downward trend in the past.

Step 8. Projected Federal Revenue per Student. Multiply the entries on Line 7 corresponding to the planning period years (Column 11 on) by the corresponding columns on Line 5. These figures are entered in the remaining columns of Line 6. They represent projected revenue per student.

Step 9. Projected Federal Revenue. Multiply the projected revenue per student (Line 6) times the corresponding projected enrollment on Line 2. The results should be rounded and entered in the remaining columns of Line 4. They represent projected federal revenue for each year of the planning period.

The projection of federal revenue to a school district using the above technique is illustrated on Form P at the end of this report. In this example, the school district has grown dramatically since the mid-1960s from approximately 8500 students in 1965-66 to 21 600 in 1974-75. During this time federal revenue per student climbed even more substantially from $8.75 per student to $32.40 per student. Assuming that the federal revenue per student is the same percentage of cost per pupil in the future as in 1974 (i.e., 2.7 percent), then federal revenue per student is projected to grow to $45.74 in 1984. When multiplied by the projected enrollment, the total federal revenue is forecast to climb to $1,124,000 in 1984.

The projected federal revenue on Line 4 should be entered on Line 225 of Summary Form B. Lines 210, 220, and 225 can then be summed and the total entered in Line 230. This total represents a projection of the school system's total revenue from all sources.

4.5.3 Bonding Capacity

In some cases the revenue raised from local, state, and federal taxes will be sufficient to defray capital as well as operating costs. This may be true if the proposed facility plan is modest, or if financial mechanisms such as leasing, a construction sinking fund, or a governmental loan can be arranged. Often, however, the sale of bonds will constitute the only way to raise construction or modernization funds. For most districts this will require that their bonding capacity be examined.

The calculation of gross bonding capacity is based primarily on a community's assessed valuation. In some cases, additional variables will also contribute to the determination of bonding limits. If these variables have not already been projected specifically in this chapter, the user must supply the forecasts or develop them, using one of the techniques already described.

Gross bonding capacity is defined as a percentage of total assessed valuation beyond which indebtedness is not permitted. The percentage is established, in most cases, by state law. Net bonding capacity is the gross bonding capacity minus any outstanding bonded indebtedness. Procedures have been prepared to project the net bonding capacity as it changes in relation to the assessed valuation, the retirement of existing debt, and the retirement of any new bonds that are issued to support the facility plan.

These procedures allow the district to identify the extent to which it could raise additional funds through the bond market without exceeding the permitted indebtedness limit. If examination of a proposed bond issue reveals that it exceeds the bonding capacity, either the amount of the proposed issue must be reduced or the terms of the issue adjusted. In the first instance, decreasing the size of the bond issue would require either cutting back on planned improvement or covering a larger portion of planned capital expenditures out of current income. Consider, for example, a situation where, after completing the Facility Component analysis, a school district determined that an additional wing was needed on an existing school and that a bond issue was the only way to finance the cost. If the analysis outlined below revealed that net bonding capacity was negative (i.e., a bond issue of the required magnitude would not be legal), then the feasibility of the new wing would have to be reexamined. The district would have to review existing facilities, revise its space standards and policies, and/or build fewer new classrooms. Alternatively, the district might attempt to pay a portion of the cost out of current income, assuming that its cash flow and state legislation allowed this option.

The third possibility would be to rearrange payments on the principal, scheduling more in those years where the bonding capacity was positive and less in those years where the capacity was negative. In cases where the bonding capacity was negative throughout, payments on principal might be delayed until a future time period. Again, these choices would be dependent upon laws regarding debt retirement, the bond market, and upon the district's cash balance.

4.5.3.1 BONDING CAPACITY FORECASTING PROCEDURES

Districts that need to determine whether they have sufficient capacity to finance a facility plan by issuing additional bonds, should use Summary Form C. Knowledge of state legislation concerning bonding limits is necessary, as well as projections of assessed valuation, payments on existing debt, and the proposed size and terms of the new bonds.

Step 1. Assessed Valuation. Place the years of the planning period on Line 300. Enter the projected total assessed valuation for each future year on Line 301 of Summary Form C. It is found on Line 201 of Summary Form B.

Step 2. Other Variables. Enter projections for any other variables that contribute to the basis on which gross bonding capacity is calculated on Line 302.

Step 3. Total Capacity Base. Sum Lines 301 and 302 and record the totals on Line 303.

Step 4. Bonding Capacity Percentage. Enter the percentage by which gross bonding capacity is determined on Line 304.

Step 5. Gross Bonding Capacity. Multiply Line 304 times Line 303. Enter the totals on Line 305. These figures now represent the school district's gross bonding capacity for each year of the planning period.

Step 6. Current Indebtedness. Enter the current outstanding bonded indebtedness in Column 10 of Line 306. This will reflect the amount owed on outstanding bonds at the end of the current year.

Step 7. Debt Retirement. Enter the bond retirement schedule in the appropriate columns of Line 307. These amounts should represent the payments on principal which have been planned for each year in the future to amortize all existing bonds.

Step 8. Future Indebtedness. Subtract the payment in year t, Line 307, from the current indebtedness in year t-1, Line 306. This will yield the remaining indebtedness that can be expected on existing bonds at the end of year t, after all retirement payments have been made. The calculation should be carried out for all years of the planning period and recorded in the appropriate columns of Line 306.

Step 9. Net Bonding Capacity. The net bonding capacity is calculated by subtracting the school district's indebtedness on Line 306 from its gross bonding capacity on Line 305. Enter the results on Line 308. These figures will indicate the maximum amount of additional bonds that could be issued for different years in the future, based on the projected change in assessed valuation and the planned debt retirement schedule.

Step 10. Planned Facility Expenditures. Calculate the probable size and timing of bond issue necessary to support the planned facilities. Enter the value of the first proposed issue in Line 309 in the column corresponding to the year in which it is tentatively planned to be issued. The probable expenditures for new land and new or renovated facilities have been calculated in Section 4.3. New bond issues should be considered if it is not possible to finance these proposed facilities out of current revenue, a sinking fund, a leasing arrangement, or a state loan.

Step 11. Planned Retirement Schedule—New Issues. Calculate a tentative retirement schedule for the proposed future bond issue in light of the expected terms and requirements. The first scheduled payment on principal for the proposed issue should be recorded on Line 310 in the appropriate year.

Step 12. Impact on Future Indebtedness. Subtract the payment on the proposed bond in year t+1 from the indebtedness in year t for the proposed bond issue. The entry on Line 310 should be subtracted from the previous year column of Line 309.

Steps 11 and 12 should be used to complete all columns on Lines 309 and 310. If a second bond issue is planned, the value of that issue must be added to the planned bonded indebtedness in the year of issue, and the retirement schedule included in the appropriate columns of Line 310. The following formula may be used as a guide to the calculation of planned bonded indebtedness:

$$BI_t = BI_{t-1} - RS_t + NB_t$$

where,
BI = bonded indebtedness

RS = retirement schedule
NB = new bond issue

The example illustrated on Summary Form C presents a district that proposes two bond issues: a million dollars next year, and two million dollars in four years. The calculations of bonded indebtedness in the fourth year (Line 309, Column 14) involve subtracting the $100,000 payment on principal from the previous year's $800,000 indebtedness, and then adding the amount of the new issue.

Step 13. Proposed Net Bonding Capacity. The impact of all proposed indebtedness on the net bonding capacity may be calculated by subtracting the values on Line 309 from the corresponding values on Line 308. Enter these new net bonding capacity figures on Line 311. The values on Line 310 represent the future net bonding capacity of the school system in light of the proposed bond issues. If any of the totals on this row are negative, the user must make adjustments by decreasing the amount of the proposed issues or by rescheduling payments on principal.

4.5 The Fiscal Plan

The final requirements of the component is the development of a fiscal plan by comparing projected revenues and expenditures. Preparing this fiscal plan may require that several of the entries on the Summary Forms be recalculated as alternative conditions and programs are analyzed. Throughout this process, the user is encouraged to keep in mind all assumptions underlying the projected variables. For example, if a conservative estimate of the expected inflation rate was used to calculate the building cost index, and, therefore, capital expenditures, the user should insure the ability to meet additional expenditures should the inflation rate be higher than forecast. This precaution might be achieved by requiring a safety margin either in the cash balance or in the net bonding capacity. The importance of contingency planning, so that a district can react effectively if certain projections do not materialize, cannot be overemphasized.

Much of the fiscal analysis associated with the closing or construction of specific buildings cannot be done with a pre-defined form. Instead, all incremental changes in both revenue and costs must be considered, totaled, and then added onto the appropriate lines of Summary Form D. The closing of a school may result in reduced operating costs because of lower utility, maintenance, insurance, and administrative overhead. These savings may be partially offset by increased school bussing requirements, demolition, or higher security costs. School district income might also be affected if the building and site are leased or sold.

The construction of a new building will have an equally diverse impact on operating, as well as capital, costs. New requirements must be established for changing light bulbs, plowing parking lots, purchasing library books, and the hundreds of other necessary supply and service activities. More difficult will be the determination of additional staff necessary to meet custodial and administrative requirements. The difference in operating costs due to utility transportation, and other factors may be important in deciding between building a new structure versus adding to an existing one.

4.6.1 FISCAL PLAN PREPARATION PROCEDURES.

Preparation of a fiscal plan capable of supporting the proposed facilities can be best accomplished by assembling previously calculated information onto Summary Form D. The impact of policy alternatives can then be examined by varying selected entries on this form.

Step 1. Projected Revenue. Enter the years of the planning period on Line 400. Enter total revenues projected from state, federal, and local sources for each future year on Line 405. These are transferred from Line 230 of Summary Form B.

Step 2. Projected Operating Costs. Enter total operating expenditures on Line 410 for each year of the planning period. These are transferred from Line 107 of Summary Form A.

Step 3. Projected Non-Revenue Income. Enter total bond receipts in the year that the system will receive the income on Line 415. For example, if a bond issue is planned for the fifth year of the planning period, the total should be entered in Column 15 of Line 415.

Step 4. Principal-Existing Bonds. Enter scheduled payments of principal on bonds already outstanding on Line 421. These are transferred from Line 307 of Summary Form C.

Step 5. Interest—Existing Bonds. Enter scheduled interest payments on bonds already outstanding on Line 422.

Step 6. Principal—Proposed Bonds. Enter planned payments on principal on all proposed bond issues on Line 423. These are transferred from Line 310 of Summary Form C.

Step 7. Interest—Proposed Bonds. Enter planned interest payments for any proposed bond issues on Line 424.

Step 8. Projected Total Bond Payments. Sum Lines 421 through 424 and record the total on Line 425.

Step 9. Projected Capital Costs. Enter total proposed capital expenditures for each year of the planning period on Line 430. These are transferred from Line 103 of Summary Form A.

Step 10. Total Revenue. Sum Lines 405 and 415 and record the totals on Line 440.

Step 11. Total Expenditure. Sum Lines 410, 425, and 430 and record the totals on Line 450.

Step 12. Projected Cash Flow. Subtract Line 450 from Line 440 and record the differences on Line 460. Line 460 contains the projected cash flow for each year of the planning period.

Step 13. Projected Balance. Calculate the projected school district cash balance. Enter the current year's balance in Column 10, Line 470. Add the projected cash flow in Column 11, Line 460, to the current balance and enter this number in Column 11, Line 470. The balance for each year of the planning period will be calculated by adding the cash flow for that year to the preceding year's balance. These totals are recorded on Line 470.

Step 14. Alternative Considerations. Examine the fiscal impact associated with alternative facility plans and alternative community conditions, by varying the entries on the appropriate lines. Consider, for example, the effects of a change in assessed valuation, enrollments, or tax rate on the district's income; and the effects of a change in the teacher's contract, interest rate, or inflation on the district's expenses. Review of possible eventualities, in addition to the most probable conditions, will be necessary if the uncertainty that surrounds the future is to be adequately examined.

If, after completion of Summary Forms C and D, the user finds that the net bonding capacity and the cash balance are both positive for all years, and if a sufficiently large margin exists to compensate for the uncertainty in the forecasts, the possibility of a tax reduction may be considered. In this case, the user may reduce the tax rate on Line 202 of Summary Form B and recalculate Line 203, revenues from property taxes. Next, the user should adjust the total on Line 400 of Summary Form D and recalculate the necessary totals. Several different passes through the system may be required before a feasible tax rate is obtained.

In most cases, however, the problem will not be to reduce taxes, but to increase them. If the cash balance or the net bonding capacity is negative, adjustments will have to be made. The school district must adjust its fiscal plan in view of its needs, local policy, and economic conditions. If the cash balance is positive but the net bonding capacity is negative, the user might consider rescheduling payments on principal as suggested above. The new payment schedule would be entered on Line 423 of Summary Form D and the necessary totals recalculated. Again, several passes through the system may be required before a new bond payment schedule is developed that produces a positive net bonding capacity and cash balance.

Another alternative, particularly in cases where the net bonding capacity becomes negative as soon as the proposed issue is entered, is to divide the proposed bond issue into several smaller issues. Each new bond issue would be initiated for the period in which a sufficient amount of the principal on the preceding bonds have been paid off to permit further indebtedness. In this case Lines 309, 310, and 311 of Summary Form C should be recalculated.

The interest rate associated with a proposed bond issue must also be examined. When the bond is planned, the repayment schedule and the legal limits on indebtedness will both be major considerations. However, an equally important factor is the uncertainty associated with forecasting the interest rate. In developing the fiscal plan, the user should experiment with different interest rates, including the maximum allowed in the state.

The impact of different rates on proposed interest payments should be determined, entered on Line 424 of Summary Form D, and then the cash flow recalculated. This process may identify an interest rate ceiling for the proposed issue which could not be exceeded if the debt is to be retired on schedule. When it appears that market conditions must require a higher interest rate, adjustments will again be necessary, either in the size of the issue or in other factors affecting the cash balance. If the cash flow is negative and no further adjustments can be made in the district's projected revenue or the bond's repayment terms, the facility plan will have to be scaled down.

When a negative cash balance is projected, the district must either increase revenues and/or decrease expenditures. From a practical standpoint, most local school systems have little or no control over the amount of revenues received from the state. The possibility of raising the local tax rate may be more feasible. As in the case of reducing the tax rate, experimentation with several different rates on Summary Forms E and D is recommended in order to arrive at a workable rate. On the expenditure side, the district may have several options. Since teachers' salaries constitute the largest portion of operating expenditures, a decrease in the number of teachers and/or administrators might be considered. Of course, decreasing the number of teachers may well necessitate a change in the pupil-teacher ratio. Trade-off considerations between decreasing expenditures and lowering standards will be necessary. In making adjustments to the fiscal plan, the district must be alert to the impact these adjustments will have on all other aspects of the educational process.

Chapter 5: Geographic Component

The purpose of the Geographic Component is twofold: 1) To aid in establishing school attendance area boundaries which will minimize student travel expense, time, or distance to school, and 2) To assist in selecting sites for a new school or school closing. Essentially, both issues involve the same problem, i.e., assigning students to schools in such a way that the total distance traveled by all students is minimized.

5.1 General Design

Designating attendance boundaries and selecting a facility site are difficult assignments because of the variety of unique factors that must be considered. A railroad track, major street, or inexpensive parcel of ground are typical of the many situations that must be examined on a case by case basis.

However, the intuitive solution to a school locational problem that results from looking at a map often will not be the "best" in terms of reducing the distance that all students must travel. The Geographic Component is based on the premise that a more rigorous approach may be useful, as long as it does not disregard the district's unique characteristics.

Assigning students to various schools within a district is a transportation problem to which linear programming is applicable. This is an established technique for determining the best or optimal allocation of some limited resources to meet a particular objective. As applied here, the linear program produces a solution which will minimize the total distance traveled, however measured, by all students to their assigned school. The only constraint is the obvious requirement that no school can accept more students than its capacity.

With the computer-based version of the School Facility Planning System additional analysis is possible, such as that necessary to achieve racial balance within the district. However, to seek manually an optimal solution under any constraints other than the school capacity limitations would be impractical because of the substantial increase in time required to perform the additional calculations. Therefore, the following procedures deal with the minimization of distance traveled by all students to their respective schools.

The procedures are based on a particular linear programming technique known as the "Distribution Method." This technique is applicable to all schools within a district that fall within the same system organization category, e.g., elementary schools, middle schools, or high schools.

5.2 School Attendance Boundary Procedures

The assignment of students from small geographic areas to schools requires the performance of eight basic steps, some of which are in turn divided into a series of sub-steps. Steps 5 through 7 are repeated until an optimal allocation is identified.

No specific form is required to conduct the computations. However, it is recommended that the information be organized in a consistent manner, as illustrated in the example that follows. Three categories of information are necessary; enrollment, school capacity, and distance.

Step 1. Data Collection. Assemble the information necessary to analyze the problem as follows:

1. Enrollment. Projected student information must be collected by small areas or grids, and by grade organization throughout the district. Techniques for making projections by area and grade organization are described in Chapter 2, "Enrollment Component." It should be noted that the model minimizes transportation distance for a particular year. Therefore, when attendance areas are being established to last for more than a year or when a site is being selected, repeating the procedures for different years may be appropriate to account for the anticipated change in projected enrollments.

2. School Capacity. The ability of each school within a grade organization to accommodate students must be determined. This will have been calculated in Chapter 3, "Facility Component." Capacity is measured in terms of potential students that could be housed, given the physical school space and the district's space standards.

3. Distance. The distance from the approximate center of population of each area to each school must be measured in either time, miles, or travel expense. The user should decide which measure of distance is most suitable. For example, a school district which covers a large geographic area and contains one or more highways might show large distances between various residential locations and schools within the district, but, because of the use of highways, might be characterized by travel times well within acceptable limits. Such a district should consider measuring travel time as opposed to distance. If the user chooses to calculate distance in mileage, the measurement should be done using a street map of the district to determine the mileage over the most direct street route as opposed to straight line distances from each grid to each school.

Step 2. Work Sheet Preparation. The information should be recorded in a tabular or matrix format so that the columns represent all elementary, middle or high schools to be considered and the rows represent each grid or area in the district. The far right-hand side column should contain the projected total enrollment by grid, and the bottom row should contain the enrollment capacity per school. The distance from each area to each school should be displayed on the right side of every cell in the matrix.

To illustrate this format, assume there is a school district which contains three elementary schools, grades K-6, which will be numbered 1, 2, and 3, with enrollment capacities of 300, 400, and 350 respectively. Further assume that the school district has been divided into five areas or grids, and that the projected K-6 grade enrollments are as follows:

Grid No.	K-6 Projected Enrollments
1	100
2	200
3	100
4	300
5	200

In the example the distances from the population center of each grid to each school has been measured in miles using street maps to determine the most direct street routes. Thus, the center of population of grid 1 is five miles from school 1 over the most direct route. Determining the center of population for each grid must be left to the user's judgement. While necessarily somewhat arbitrary, the use of such a starting point to determine distance to schools is sound. Figure 5-1 presents the example information in the recommended format. Notice that an extra row, grid no. 6 has been allotted and will be explained below.

FIGURE 5—1 DISTANCE MATRIX

From/To		Schools			Projected Enrollments by Grids
		1	2	3	
Grids	1	5	3	4	100
	2	2	5	3	200
	3	4	2	1	100
	4	1	4	5	300
	5	4	3	2	200
	(6)	0	0	0	
Enrollment Capacities		300	400	350	

Step 3. Initial Assignments. Once the data has been calculated, students in each grid should be assigned to the nearest school by examining the respective distances. Using the sample data, this assignment might be as follows:

Grid 1 containing 100 students is closest to school 2; therefore, the 100 students from grid 1 are assigned to school 2. Note that the remaining enrollment capacity of school 2 has now been decreased from 400 to 300.

Grid 2 with 200 students is closest to school 1; therefore, they are assigned to school 1, thus reducing the remaining enrollment capacity of school 1 to 100. The same procedure is followed for grid 3.

Grid 4 contains 300 students and is closest to school 1, but school 1 has only a 100 student capacity remaining. Therefore, 100 students from grid 4 are assigned to school 1 and the remaining 200 students are placed in the next closest schools, capacities permitting. In this case all remaining 200 students can be placed in school 2, thus reducing its capacity to 100.

Grid 5 is handled in the same fashion as grids 1, 2, and 3 since the 200 students from grid 5 could be placed in the closest school without exceeding its capacity.

Notice that this solution has left excess capacities of 100 and 50 students in schools 2 and 3 respectively. If excess capacity exists for any school, it must be shown as students from an imaginary grid zero miles from all schools, so that the sum of the students in each column will exactly equal the enrollment capacity of the school that column represents. Therefore 100 students are assigned to school 2 from imaginary grid 6 and 50 students are assigned to school 3. If, by chance, the projected enrollment for all grids equals the total capacity of all schools, then the imaginary grid must not be included in the matrix.

The total distance, D, traveled given this inspection solution can be determined by multiplying each circled number by its respective distance figure and summing the products as follows:

$D = (200 \times 2) + (100 \times 3) + (100 \times 1) + (100 \times 1) + (200 \times 4) + (200 \times 2) + (100 \times 0) + (50 \times 0) = 2100$

The above initial solution is illustrated in Figure 5-2.

FIGURE 5–2 INSPECTION SOLUTION

From/To		Schools			Projected Enrollments by Grid
		1	2	3	
Grids	1	5	(100) 3	4	100
	2	(200) 2	5	3	200
	3	4	2	(100) 1	100
	4	(100) 1	(200) 4	5	300
	5	4	3	(200) 2	200
	(6)	0	(100) 0	(50) 0	
Enrollment Capacities		300	400	350	

In order to determine whether the initial solution represents an "optimal" assignment of students to schools, a series of mathematical steps must be performed.

Step 4. Enrollment Identification. Circle all the enrollment figures present in the matrix. This is done to facilitate the location of enrollment figures on the work sheet. The number of circles must equal the number of rows plus the number of columns minus one. In the example, there are 6 grids (rows) and 3 schools (columns) so the number of circles must be (6+3)-1 or 8. In some instances, fewer or more circled numbers might appear than dictated by the formula. If there are fewer circles, zeros should be placed in the matrix and circled. The position of the zeros is arbitrary, but the following guideline may reduce the number of calculations necessary to find the optimal solution. When the entire enrollment of a grid is assigned to one school and that assignment exhausts the remaining capacity of that school, a zero should be placed in the next closest school for that same grid. If this is done each time the situation occurs, the number of resulting zeros should increase the number of circles to that necessitated by the formula.

If an excess of circles arises, consolidate the enrollment of that grid from which students were assigned to the largest number of different schools. If there is no single grid in which this occurs, choose arbitrarily a grid for consolidation.

It is important that the number of circles equals the number of grids plus the number of schools minus one.

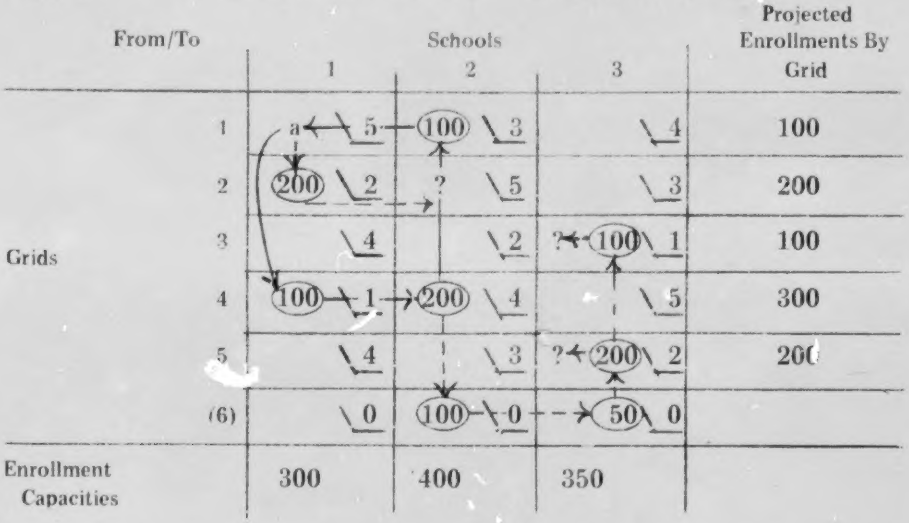
Step 5. Identification of "Paths." A value must be determined for each square in the matrix not containing a circled enrollment figure. If the value for each blank square is positive, the enrollment distribution is optimal. If one or more of the values is negative, the distribution can be improved to further minimize travel distance, time, or expense.

To obtain the value for a blank square, a path must be traced beginning and ending with that blank square in the following manner.

Move in a horizontal or vertical, never diagonal, direction from the blank square to a square containing a circled number. Every subsequent step must be a horizontal or vertical move to another circled number except for the last step, which will end on the blank square from which the path originated. Upon reaching the first circled number, a right-angle turn to either the left or right is necessary. The path is then traced to a second circled number and a right-angle turn is made again. This pattern must be followed until a right-angle turn from a circled number leads back to the blank square from which the path originated.

If the matrix has been properly formulated and if the path is properly traced, only one correct path will exist for any given starting point. Figure 5-3 illustrates this process beginning with grid 1, school 1 which has been designated "a." Moving from "a" to grid 2, school 1 (as represented by the dotted line) is a proper move; but upon making a right-angle turn at 200, a path cannot be continued to another circled number. Therefore, this move cannot be part of the proper path for starting point "a."

FIGURE 5–3 ALTERNATIVE PATHS–STARTING POINT "a"



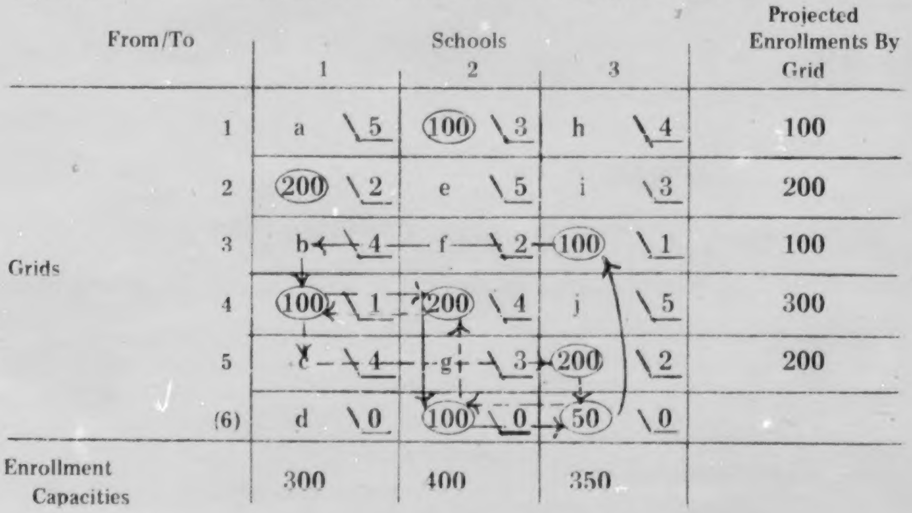
From/To		Schools 1	2	3	Projected Enrollments By Grid
Grids	1	a \ 5	100 \ 3	\ 4	100
	2	200 \ 2	? \ 5	\ 3	200
	3	\ 4	\ 2	? 100 \ 1	100
	4	100 \ 1	200 \ 4	\ 5	300
	5	\ 4	\ 3	? 200 \ 2	200
	(6)	\ 0	100 \ 0	50 \ 0	
Enrollment Capacities		300	400	350	

Moving from "a" to grid 4, school 1, as designated by a solid line, represents a more promising move because, upon making a right-angle turn from 100, another circled number 200 lies in the path. A right-angle turn from 200 toward grid 6, school 2, dotted line, will lead to 100 and a right-angle turn from 100 to grid 6, school 3, will lead to 50. But a right-angle turn from 50 will not lead to any other circled number that could eventually trace a path back to starting point "a"; therefore, this path would not be appropriate.

The proper path for "a" is illustrated by the solid lines. All the requirements for tracing a path are met.

The solid line in Figure 5-4 traces the proper path for b. Any path may be traced clockwise or counter-clockwise with no change in results. It is possible for a path to cross over itself if the lines of the path are perpendicular to one another. The dotted line path traced for starting point "c" in Figure 5-4 offers an example.

FIGURE 5–4 ALTERNATIVE PATHS–STARTING POINTS "b" AND "c"



From/To		Schools 1	2	3	Projected Enrollments By Grid
Grids	1	a \ 5	100 \ 3	h \ 4	100
	2	200 \ 2	e \ 5	i \ 3	200
	3	b \ 4	f \ 2	100 \ 1	100
	4	100 \ 1	200 \ 4	j \ 5	300
	5	c \ 4	g \ 3	200 \ 2	200
	(6)	d \ 0	100 \ 0	50 \ 0	
Enrollment Capacities		300	400	350	

Step 6. Determination of values. When tracing each path, alternate plus (+) and minus (-) signs are associated with the move to each circled number. Assign a plus to the starting point distance, a minus to the first circled number distance, a plus to the next circled number distance, minus to the next, and so on The distance associated with the circled number from which the path will lead back to the starting point is always minus. This is due to the characteristics of a properly formulated matrix which is that there will always be an even number of steps in every path traced. Since each path begins with a plus, it must end with a minus. The distance figures associated with each step in a path must then be added to or subtracted from the other distance figures in that path according to the sign associated with them. This process will result in a value that must be placed in the box associated with the starting point of that particular path.

In the example the values for starting points a through j are as follows:

a. +5-1+4-3 = 5
b. +4-1+4-0+0-1 = 6
c. +4-2+0-0+4-1 = 5
d. +0-1+4-0 = 3
e. +5-4+1-2 = 0
f. +2-0+0-1 = 1
g. +3-0+0-2 = 1
h. +4-3+0-0 = 1
i. +3-2+1-4+0-0 = -2
j. +5-0+0-4 = 1

Step 7. Matrix modification. Review of the values for each blank square in the example reveals one blank square to be negative, thereby indicating that the matrix can be improved. The point at which the improvement can be made is in the negative square. If more than one negative square exists, selection of the most negative square will usually result in a quicker solution.

In the example square "i" should be chosen since it is the only negative square. Retrace the path for starting point "i", assigning plus or minus signs to each step as described above. The matrix must now be changed in accordance with the following rules:

A. Select the smallest negative-path circled number. Negative-path circled numbers are those enrollment numbers with negative signs assigned to their square. The smallest negative-path circled number for "i" is 50.

B. Subtract the above number from all negative-path circled numbers, including itself. Subtract 50 from 50, and from 200 twice. The remainders are 0, 50, and 150.

C. Add the smallest negative-path circled number to all positive-path circled numbers. Add 50 to 0, 100, and 100.

These are the only changes necessary unless there happens to be another negative value blank square whose path is completely independent of the path of the first negative value blank square. Such an additional negative value square would be one whose path does not step on any of the circled numbers traced in the path of the negative value square selected first. If the two paths are not independent, the circled numbers in the path of the second negative value square would also have been changed under the above rules. Changes required for the square "i" path are shown in Figure 5-5

The savings in travel distance created by altering the matrix is determined by multiplying the circled number 50 placed in square i, by the negative value of square i or (-2). Thus, the reduction in distance traveled is 50 x -2 = -100

To find out whether the new enrollment distribution is optimal, blank square values should again be calculated in a search for any new negative values. If none are found, the allocation of students to schools will be optimal. If additional negative values are identified, the matrix could be improved further. This process should be repeated until no negative values are found for any blank squares.

FIGURE 5–5 MODIFIED MATRIX

From/To		Schools 1	Schools 2	Schools 3	Projected Enrollments By Grid
Grids	1	5 \5	(100) \3	3 \4	100
	2	(150) \2	0 \5	(50) ✓ \3	200
	3	4 \4	-1 \2	(100) \1	100
	4	(150) \1	(150) \4	3 \5	300
	5	3 \4	-1 \3	(200) \2	200
	(6)	3 \0	(150) \0	2 ✓ \0	
Enrollment Capacities		300	400	350	

The tasks required in checking the blank square values and making appropriate changes are summarized below:

1. Select any square that does not contain a circled number
2. Trace the path, stepping only in circled squares, except for the step back to the starting point. Notice that in Figure 5-5, a check mark (✓) has been placed in those squares where a circled number has been added or removed. If any paths retraced do not step in a square with a (✓), the blank square value for which the path was traced need not be recalculated since it will be unchanged from the first tracing.
3. Make a right-angle turn at each square on the path.
4. List alternating plus and minus signs for each move taken on the path.
5. Relate the distance figures to the alternating signs.
6. Total these figures for the path traced. This total is the blank square value.
7. Retrace the path for any negative value blank square and mark the path with alternating signs.
8. Select the smallest negative-path circled number.
9. Subtract the smallest negative-path circled number from all negative-path circled numbers, including itself.
10. Add the smallest negative-path circled number to all positive-path circled numbers, including the blank square containing the negative blank square value.
11. Circle any new enrollment figures and check to see that the sum of all circled numbers is equal to the number of rows plus columns minus one. If necessary, add a circled zero, or consolidate several enrollment numbers.
12. Repeat tasks 1 through 11 until no negative blank square values are found.

Figure 5-5 indicates the blank square values arising from the changes made in the matrix. Notice that now there are two negative blank square values. Since they have the same value, there is no reason to choose one over the other to change the matrix. Figure 5-6 illustrates the additional changes made in the circled numbers and the new blank square values arising from those changes.

The second negative blank square value is found in grid 5, school 2 thus requiring another change in the matrix. Figure 5-7 illustrates the results of these changes.

Figures 5-6 and 5-7 are illustrated on the following page.

FIGURE 5–6 MODIFIED MATRIX

From/To		Schools						Projected Enrollments By Grid
		1		2		3		
Grids	1	5	\5	(100)	\3	3	\4	100
	2	㊿	\2	0	\5	(150)	\3	200
	3	5	\4	(100)✓	\2	1✓	\1	100
	4	(250)	\1	㊿	\4	3	\5	300
	5	3	\4	-1	\3	(200)	\2	200
	(6)	3	\0	(150)	\0	2	\0	
Enrollment Capacities		300		400		350		

FIGURE 5–7 OPTIMAL SOLUTION

From/To		Schools						Projected Enrollments By Grid
		1		2		3		
Grids	1	4	\5	(100)	\3	2	\4	100
	2	⓪	\2	1	\5	(200)	\3	200
	3	4	\4	(100)	\2	0	\1	100
	4	(300)	\1	1✓	\4	3	\5	300
	5	3	\4	㊿✓	\3	(150)	\2	200
	(6)	2	\0	(150)	\0	1	\0	
Enrollment Capacities		300		400		350		

This time there are no negative numbers, thus indicating that an optimal solution has been reached. Notice that in grid 2, school 1, there is a circled zero ⓪. Adding this circle meets the requirement that there be as many circled numbers in the matrix as the number of rows plus the number of columns minus one.

The total distance traveled by students under this final enrollment distribution is:

D = (300 x 1) + (100 x 3) + (100 x 2) + (50 x 3) + (150 x 0) + (200 x 3) + (150 x 2) = 1850.

This represents a 250 mile reduction in total required distance compared to the 2100 miles that would be traveled under the inspection solution.

Step 8. Draw Boundaries. The optimal solution indicates which students should be assigned to which schools in order to minimize the total distance traveled. In most cases all the students in a given grid will be assigned to one school. However, in some instances the grid enrollment must be divided among schools. Notice that 50 students in grid 5 in the example are assigned to school 2, and 150 are assigned to school 3. This division should be made judgementally so that the appropriate proportion of students within the grid are assigned to the correct schools, while at same time selecting natural or reasonable boundaries. One approach would be to assume an equal yield of students per dwelling, and then to allocate dwellings to schools using a land use map or aerial photograph. If more detailed information is available concerning the distribution of students within the grid, it should, of course, be used.

The final task is to adjust the attendance boundaries so that natural division lines are respected. Thus highways, railroad tracks, creeks, and other man-made or natural features should be selected that are located as close as possible to the grid boundaries. This process will depend on the knowledge and judgement of the user rather than any mechanical procedures. It will be simplified if the areas or grids were defined using natural, instead of arbitrary boundaries.

The distribution method will always give an optimal solution when properly formulated and carried out. In fact, it is not necessary to assign students to the closest school as was done for the inspection solution. Any feasible assignment of students to schools will approach the same optimal solution.* The purpose of the inspection solution is simply to reduce the number of repetitions necessary to achieve an optimal distribution.

If the user wishes to determine the extent to which existing attendance area boundaries in the district will provide an optimal student distribution, the inspection solution should be replaced with the student distribution dictated by the existing attendance area boundaries.

Notice that the basic distance matrix, Figure 5-1, was used several times. It is suggested that the user make at least five copies of this form in order to avoid the necessity of copying the distance figures each time a check for an optimal solution is required.

5.3 Site Selection Procedures

The distribution method may also be useful in analyzing a second kind of geographic problem, that of designating a site for the closing or construction of a school. Student transportation cost is, of course, only one of many factors to be considered in the site selection process. Others have been identified in Chapter 7.

5.3.1 School Closing

In situations where projected enrollment decline will permit the closing of one or more schools, a variety of concerns must be addressed. The functional obsolescence, operating expenses, proximity to other schools, potential alternative uses, and neighborhood concerns must all be examined. However, where consideration of these factors fails to produce a single best school closing site, the total transportation distance required of all students, given each school closing alternative, may be worth reviewing.

The procedures are the same as those described in Section 5.2. Simply eliminate one of the potential school closing sites from the original distance matrix. Execute the steps for determining the optimal solution, and record the total distance traveled under that distribution. Then, beginning with the original distance matrix, remove an alternative closing site and follow the procedures for determining the optimal distribution of students given that configuration of remaining schools. Record the total distance traveled.

Comparison of the total distances traveled under each alternative school closing will reveal which school should be closed in order to minimize the distance traveled by students. This "best" alternative should then be weighed against other evaluation criteria before the final site is selected.

5.3.2 School Construction

In cases demanding the construction of new facilities, a finite number of potential school sites will usually be available. If none of these sites is an obvious choice, on the basis of the school and construction requirements, travel distance considerations may be appropriate.

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*A feasible distribution is one in which every student is assigned to a school and the enrollment of every school is less than or equal to the school's capacity.

The same procedures will determine which new site will minimize combined distance traveled by students to school. Choose any new site and add it to the original distance matrix along with the distances from each grid to that site. Assign the maximum feasible enrollment capacity to the new school as determined by construction costs, site size, availability of funds, and other factors. Follow steps 3 through 7 as outlined in Section 5.2 to find the optimal distribution. If the optimal solution assigns a number of students to the new site substantially less than the school's maximum feasible capacity, then the capacity of the new site could be reduced with no change in the optimal solution. Calculate the total distance traveled under the enrollment distribution. Repeat this procedure with a second new site and record the new total distance traveled under this enrollment distribution. Once this has been done for all potential new sites, they may be ranked according to total distances traveled by students. This, along with enrollment capacity requirements determined for each new site, can be used in the decision as to which location is most appropriate.

5.4 Analysis

One of the shortcomings of the distribution method is the amount of computational work necessary for a district with many schools and small geographic areas. The method is also hampered by the fact that only enrollment capacities of schools can serve as a constraint. If an extensive number of schools or grids exist, or if racial and other constraints are important, the computer-based Geographic Component should be considered.

The manual approach is, however, versatile enough to permit analysis of many situations that may be unique to a particular district. Several considerations in formulating the distance matrix make this possible.

5.4.1 Barriers

Every school district is characterized by certain routes between students and schools that are either undesirable or impossible to travel. A trip that requires students to cross several railroad tracks or busy arterial streets, or to pass through an industrial or commercial zone will typically be discouraged by school board policy. Other paths between students and schools may be relatively short in straight line distance, but because of barriers like a river or limited access highway may require considerably longer travel distances.

Impediments of this sort can be easily incorporated into the distance matrix. The user must remember simply to reflect the probable travel distance (or time or cost) between every grid and school, rather than the straight line distance. If, for any reason, it is decided that no students should be assigned from a given grid to a given school, this can be assured by designating an arbitrarily high distance for that square in the matrix. A statement to the effect that there are ninety-nine miles between a particular grid and school will effectively preclude any possible interaction between that grid and school.

5.4.2 Walking to School

Some districts may want to consider a policy whereby all children within some defined distance of a school are assigned to that school. This will be particularly appropriate where a district requires all students living within one mile of a school to walk, thereby reducing school bussing costs. This policy may not always be possible if, at the same time, the board does not desire to expand the capacity of a school and/or wants to minimize total student travel distance. However, the policy can be explicitly considered in formulating the distance matrix.

The specific policy must be geographically displayed on a map containing schools and grid boundaries. The simplest approach is to draw circles around each school whose radius is equal to the required walking distance. Each circle would have to be modified to account for any barriers of the type described above. All students falling inside a circle are then assigned to that school. In some instances the complete grid will be assigned. More often only a section of the grid will be affected, in which cases a proportionate estimate of grid enrollment will have to be made.

The total capacity of each school should then be reduced by the number of students assigned to that school. Similarly, where necessary, each grid must be reduced by the students designated to walk to a school. A revised distance matrix can then be prepared that reflects the remaining unused school capacity and unassigned students in each area. In situations where the complete school capacity is consummed by walking students, and/or the complete grid enrollment is assigned, each must be dropped from the new matrix.

Once the new distance matrix has been prepared, the basic *procedures can be carried out to* determine the optimal allocation.

5.4.3 Equalizing Capacity

Occasionally the minimum travel distance solution will result in an allocation plan that badly underutilizes a given school. This will be especially true in situations where the district as a whole has considerable excess capacity or the population has shifted away from certain sections of the city. The school board may understandably identify some percentage of capacity below which no school is allowed to fall. The policy might be alternatively stated so that the range between the most utilized and the least utilized school never exceeded a certain amount.

The effect of this policy is to include an additional constraint to the allocation problem. The constraint can be considered by altering the existing capacity of schools in the distance matrix, and recalculating the minimum travel distance solution. Thus, if the optimal solution achieved using actual school capacities revealed one or more schools to be severely underutilized, while others were at or near capacity, an adjustment might be in order.

The difference between total capacity for all schools and total enrollments is the total excess capacity in the district. In situations where the possibility of school closings is to be considered, the site selection procedures (Section 5.5) should be used. If an equal distribution of excess capacity among all schools is desired, new fictitious capacities will have to be determined. The capacity of each school should be reduced by applying the percent of district-wide capacity attributable to that school against the total excess capacity For example, Elementary School A with capacity for 400 students might constitute eight percent of the total elementary school capacity. If on a district-wide basis 1200 seats of the 5000 total capacity were considered excess, then the new capacity for school A would be designated as 304 students, or eight percent of 1200 (ninety-six) subtracted from 400. School B with an actual capacity of 250 students would be recalculated to have a capacity of 190 students.

Calculation of the basic allocation procedures using the new school capacity figures will yield an optimal distribution of students within the guidelines that excess capacity be equally distributed among all schools.

5.4.4 Enrollment Projections

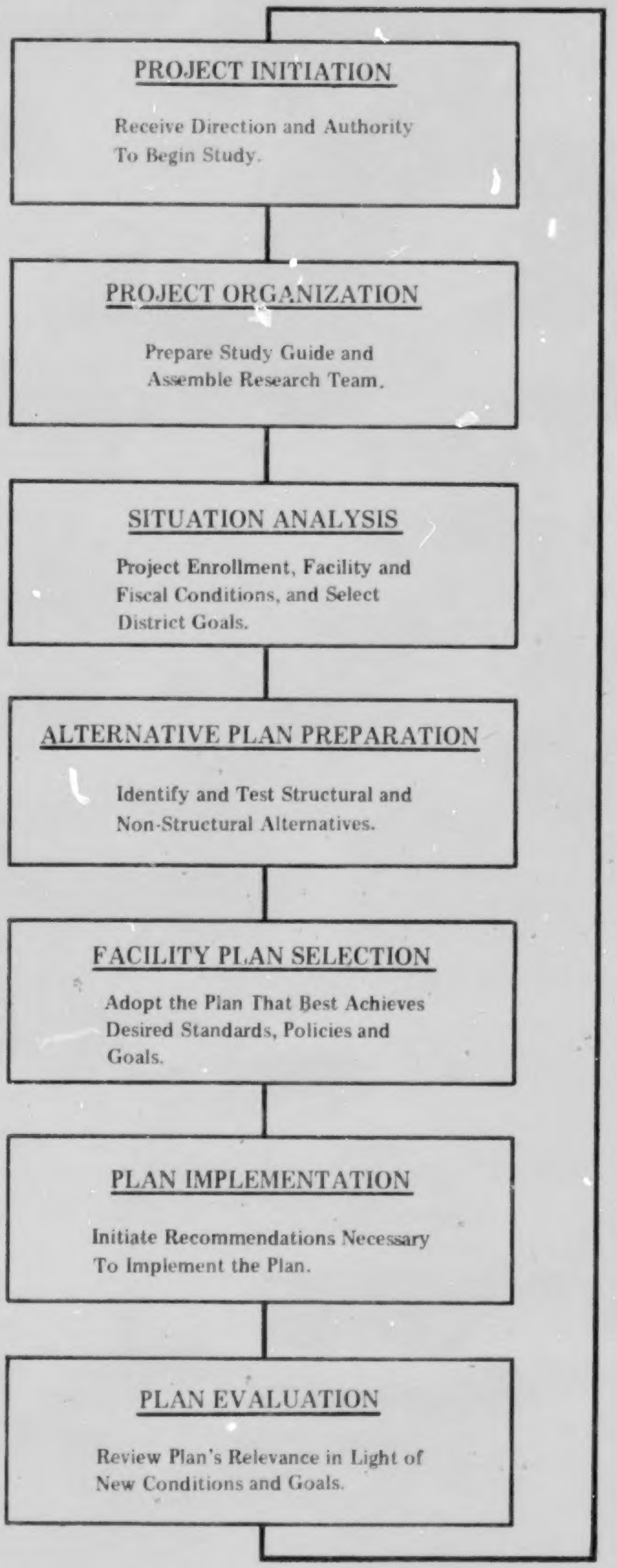
The attendance boundaries or proposed closing/construction site that minimizes student travel distance for one year, may be far from an optimal solution five or ten years into the future. This potential disparity will necessitate a decision regarding the appropriate year in the planning period for which to design. For those districts engaged in selecting attendance boundaries and willing to adjust these boundaries annually there is no problem. Next year's forecast should be used. However, for those districts interested in establishing boundaries that will last for several years, or considering construction or closings that will remain in effect for many years, the problem is different. The projected enrollment distribution must be considered.

As suggested in Chapter 1, the year upon which to base the decision must be selected in light of several considerations, especially the confidence surrounding the enrollment projections and the cost of a mistake. Wherever there is considerable doubt as to the projected enrollment pattern and the cost of a poor decision is not great, there will be a tendency to focus on the immediate horizon

Alternatively if the projected enrollment pattern seems relatively certain, and the "cost" of building in the wrong place is thought to be severe, a longer range perspective might be adopted. In general, any allocations based on a projection of more than two or three years into the future should be compared with the solution for the current grid enrollments.

The distribution method produces an optimal solution in terms of minimized travel to school by all students within a district, once the distance matrix has been formulated. However, the formulation of the distance matrix is all important in determining the relevance of the solution to a school attendance boundary or site selection problem.

FIGURE 6–1 SCHOOL FACILITY PLANNING PROCESS


PROJECT INITIATION
Receive Direction and Authority To Begin Study.
PROJECT ORGANIZATION
Prepare Study Guide and Assemble Research Team.
SITUATION ANALYSIS
Project Enrollment, Facility and Fiscal Conditions, and Select District Goals.
ALTERNATIVE PLAN PREPARATION
Identify and Test Structural and Non-Structural Alternatives.
FACILITY PLAN SELECTION
Adopt the Plan That Best Achieves Desired Standards, Policies and Goals.
PLAN IMPLEMENTATION
Initiate Recommendations Necessary To Implement the Plan.
PLAN EVALUATION
Review Plan's Relevance in Light of New Conditions and Goals.

Chapter 6: Project Organization

A school district should recognize the purpose and capabilities of the School Facility Planning System before deciding to use it. The System is designed to assist in the general analysis and formulation of a long-range school facility plan. This involves what the Council of Educational Facility Planner's Guide calls "the educational facilities survey" and "Master Plan." The System does not address that detailed planning which must precede the construction or remodeling of a specific building. Thus, any school district that has already made basic decisions as to desired school closings or school construction, and is now concerned with the implementation of such projects will have little use for this System.

The fundamental steps involved in any major long-range planning effort are reflected in Figure 6-1. The analytical components have been designed to assist school districts in the situation analysis and alternative plan preparation stages. Chapter 6 focuses on the preparatory activity that should precede actual use of the School Facility Planning System whenever a large scale project is desired.

6.1 Project Initiation

The idea to initiate development of a general school facilities plan may be derived from many sources. It may reflect recognition of a need on the part of a school superintendent, members of the school board, state officials, or citizens within the community.

It may often result from an immediate problem, such as a crowded school or a situation involving racial imbalance. No matter what the source of the idea, the successful project will be possible only if it is endorsed and supported by both the superintendent and the school board.

6.2 Project Organization

The success of the project will depend directly on the people assigned to it, and the initial considerations given to its purpose. These factors are examined below:

6.2.1 Project Leader Designation

Once the project is initiated, the superintendent must provide overall guidance and remain informed as to the project status. Responsibility for the day-to-day operational control should usually be delegated to a high-level staff assistant, such as an assistant superintendent, or, in some of the larger districts, the chief school planner. In most cases the project leader should be a generalist, able to communicate with a variety of specialized individuals. Direct access to the superintendent is essential.

6.2.2 Study Guide Preparation

Working together, the project leader and the school superintendent must give initial thought to the kind of study that will be conducted—its breadth, depth, and overall emphasis. At a minimum, this initial preparation should include:

Statement of the Problem. A written description, in not more than two or three pages, of the problem. This might include identification of general concern for many aspects, or specific concern for erratic enrollment trends, an uncertain fiscal situation, or some similar issue.

Review of Resources. Consideration must be given to the available talent, funding, and data. Potential individuals on the school staff, in professional planning agencies, and in the community at large should be considered in terms of their skill and available time. The available funding will, of course, determine the amount of data collection activity, data processing services, and professional consulting advice feasible. Conducting an overview of available data may require three or four days of local trips and telephone calls. If use of the computer-based version is a possibility, the survey should include the extent to which school district information is already in machine readable form, or in such shape that it could easily be converted. It should reveal any previous studies which have been conducted and may still be partially relevant, and it should identify potentially useful analysis and projections as prepared by the local planning department, utility companies, Chambers of Commerce, and other community institutions.

Review Community Situation. The community served by the school district will possess a variety of educational concerns. While many of these will have little bearing on the facility planning process, nevertheless the study must be sensitive to these concerns and the way in which they might be affected by the study results. If the study focus involves questions of racial balance, potential bond issues, and/or potential school closings, careful attention must be directed to the establishment of policies for releasing information to the public. The community review should also identify potential leaders to participate in the study, either in a technical or general review capacity.

The above considerations should all be made in light of the analysis that will be possible using the School Facility Planning System, and/or some similar techniques.* The severity of the problem, the available resources, and the overall community situation will, in large part, prescribe the type of analysis that is feasible and desirable.

A preliminary Study Guide should be developed that reflects these considerations. Consisting of not more than five or six pages, this report should provide preliminary suggestions as to the planning process which is believed appropriate. The report should contain initial recommendations regarding the following:

Manual or Computer-Based Version. A tentative recommendation regarding the use of the manual or computer-based version should be stated. This should be supported with a brief analysis of the probable effort required to implement each version. Attention should be directed to the possible additional benefits to be realized from the computer-based version in terms of accuracy, time saved and easy examination of alternative policies versus likely additional costs.

The Planning Horizon. A tentative recommendation should be made as to the time period for which forecasts will be appropriate. Some districts may be satisfied with a five-year forecast, whereas others will want to analyze expected trends for a fifteen or twenty-year period. Considerations outlined in Chapter 1 as to the confidence placed in forecasts, and the costs of making forecasting mistakes must be reviewed.

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*Administrators possessing the resources for a major facilities study may want to consider using products developed under the SIMU School Project. Particular attention is directed to the ENSIM 1 and 2 programs developed in Santa Clara, California, and the EDPLAN projection programs developed in Dallas, Texas.

System Components. Because the School Facility Planning System's components are modular, they may be implemented on an individual or collective basis. Those districts which do not perceive a problem in a given area, or which already have projections derived from independent analysis, may choose not to consider a given component.

Level of Analysis. Every component within the School Facility Planning System permits different levels of analysis. Enrollment projections can be made on a general district-wide basis, or for specific sub-areas by grade and racial composition. Similarly, the facility and financial analysis can be conducted at very general or specific levels. The study plan should attempt to identify that level of analysis considered appropriate.

It must be emphasized that any recommendations presented in the Study Guide should be made on a very preliminary basis, with the idea that they can be revised after the full study team has been selected and had a chance to conduct further research.

6.2.3 Assemble Research Team

Having given some initial thought to the focus and detail of the facility study, the superintendent will select and structure the study team.

Team Personnel. The size and composition of the research team will vary, depending upon the scope of the problems to be studied. Small districts that do not envision an in-depth study may be satisfied with only one or two participants. Larger districts undertaking a major comprehensive plan may desire a team of six or more individuals.

The degree to which each individual is involved will vary with the stage of the project. For example, individuals with demographic skills will probably expend most of their efforts before those individuals conducting the financial analysis. Nevertheless, it is best to identify all team members at the beginning of the project and to meet periodically on a group basis.

On most large studies, a professional community planner-architect is recommended. Such an individual should be capable of providing an independent perspective of probable long-range community development trends. In some school districts, this kind of individual may be available from the State Department of Education. In other districts, the services of a local public or private planning firm may be desirable.

Under the direction of the project leader, the research team's first assignment should be the examination and revision of the preliminary Study Guide.

Responsibilities. Research responsibilities should be assigned with careful attention to individual capabilities and the magnitude of the project. Responsibility must be assigned for each of the components that will be used.

1. Enrollment Forecast. To the extent possible this should be assigned to an individual with quantitative or statistical skills. He or she may be assisted by one or more individuals with some experience in long-range planning and the ability to consider alternative assumptions.
2. Existing Facility Inventory. If a detailed inventory is desired, a professional architect and engineer should be retained. This will be necessary if extensive consideration of the future adequacy of each building is to be made. Districts undertaking a less detailed inventory may assign a maintenance supervisor or other administrative staff member to the task.
3. Standards and Policies. This task should be undertaken by an individual familiar with the overall educational philosophy and curriculum plans in the district. Some school districts may want to establish a separate committee to develop or revise a district-wide organization plan which will yield this information.
4. Financial Analysis. Typically this will be conducted by the school business officer, perhaps assisted by a bond attorney or some other individual with financial experience.
5. Public Relations. Responsibility should be assigned to one individual for coordinating the release of information to the public. Poorly interpreted information or its untimely release can be damaging to a research effort; therefore this activity must be

closely controlled. Prudent communications planning can also result in building a sense of community awareness and support for the facility plan.

6. Data Collection. Some research projects may be of such magnitude that a separate team is needed for data collection.

Schedule. The school superintendent and board should establish a research schedule. A typical schedule may vary anywhere from four to twelve months in duration. The schedule should include anticipated completion dates of intermediate research phases and recommended release dates for selected research findings. In addition to these recommended deadlines, the schedule should provide for a routine meeting of the study group at least every three or four weeks.

Advisory Committee. In many districts, it will be advisable to supplement the research activities of the study team with a citizen's advisory committee. Depending upon the desires of the school superintendent and the board, such a committee can serve several purposes. Potential contributions include providing general project direction establishing contacts with various community agencies, and formally endorsing the final school facilities plan. Some districts may engage the advisory committee in research activities; other districts will prefer that its role be limited to reviewing plans after they have been prepared by the staff.

The composition, responsibilities, and schedule of both the study team and any advisory committees must be incorporated into the revised Study Guide. This set of recommendations should then provide sufficient information to guide all research activities during subsequent months. The document need not be formal, but it should be reviewed and endorsed by both the superintendent and the school board. As such, it should clearly state the nature of the end-product which the board can expect. In some cases, this product will consist of the one plan which the study team considers best suited to accommodate future trends in the district. Other boards may prefer a series of alternative plans from which they can select.

There is no one best approach to the planning process. It must be tailored to the unique conditions that characterize a given school district. However, in most cases the successful school facilities plan will directly reflect the amount of thought and commitment devoted to the particular planning process by which it was developed.

Chapter 7: Planning Considerations

Previous chapters have outlined the mechanics of the School Facility Planning System and the considerations to be made in organizing a facility planning project. The purpose of this chapter is to assist the user in selected aspects of the planning process. The initial section suggests ideas to consider in the design or formulation of specific facility plans. The next section provides suggestions for conducting a background analysis and specifies data necessary to support the System. The final section outlines considerations to be made in re-running the System and revising the plan in subsequent years.

For some experienced administrators the chapter will be quite basic. Those concerned only with the specific system instructions, or those who have a distinct facility plan which they desire to test may wish to skim the material. On the other hand, those with less experience in facility planning or with no definite solution to their school situation in mind will probably find it helpful.

7.1 Plan Formulation

The steps that constitute the facility planning process have been reviewed in Chapter 6 "Project Organization." They include:

1. Project Initiation
2. Project Organization
3. Situation Analysis
4. Alternative Plan Preparation
5. Plan Selection
6. Plan Implementation
7. Plan Evaluation

The four major components that make up the School Facility Planning System have been developed to assist in analyzing a unique school district situation, and in the testing and evaluating that lead to the selection of a plan among several feasible alternatives. However, no component specifically addresses the procedures whereby alternative facility solutions are formulated. With few exceptions, this process cannot be reduced to a specific formula or series of discrete steps, but must depend on the judgement and intuition of the user.

7.1.1 Situation Analysis

Prior to discussing specific plan formulation considerations, it may be useful to review the nature of the facility planning problem. The school planner's assignment is not unlike that of many other public or private corporation planners. The first task is to project the demand for a product (in this case education), and then to translate that general demand into a set of specific requirements necessary to meet it.

The difference between required space and existing space (as estimated in the Facility Component) will represent a measure of the ability of the school district's existing facilities to accommodate expected future levels of demand. When the school capacity is anticipated to fall below projected demand, or when the projected demand is anticipated to fall far below existing capacity, a definitive facility plan will usually be required.

In most situations the school district will be presented with a substantial number of options. Some of these options imply significant investments or disinvestments in the school plant (e.g., the construction or abandonment of a school building). Other options may be termed "non-structural." Since the capacity of a school may be significantly altered by modifying district standards and policies, the actual building or closing of a facility should be only one of many choices to be considered.

7.1.2 Plan Design

When analysis of the local situation reveals that an unsatisfactory condition exists or is projected to exist, a series of potential solutions must be developed. No one approach is necessarily more correct than others in formulating these alternatives.

The challenge is to prepare a reasonable number of options that can be subjected to critical review by the staff, school board, and community. Typically, a range of alternatives should be sought that neither concentrates solely on the most expedient solutions nor focuses on too many "far out" alternatives which from a practical viewpoint could never succeed. The first approach may miss non-conventional, but potentially feasible solutions; the second approach will often be conducted at the cost of wasted time, false hopes, and increased frustration. Unfortunately, there is no way to generalize about the proper focus. Consideration of the twelve-month school year, a "school without walls," or a tax rate increase, for example, may be very legitimate options in some communities, while being completely unrealistic in others.

In general, those districts with the time to examine the trade-offs associated with a variety of different solutions will produce a better plan. At minimum, each solution should be evaluated in light of the following considerations:

— Capacity. The extent to which the solution is likely to accommodate projected enrollments while remaining within the school system's range of acceptable standards and policy criteria.

— Existing Facilities. The extent to which the solution makes the best possible use or reuse of the school system's existing physical plant.

— Educational Philosophy. The extent to which the solution meets the school board's and the community's goals, as reflected by the desired instructional program.

— Financial Resources. The extent to which the solution can be accomplished within operating and capital cost limits acceptable to the community.

— Location. The extent to which the solution meets the travel time, attendance area composition, and other geographic guidelines as desired by the local community and state or federal officials.

A list of the basic options to be considered in formulating alternative plans is outlined below. These options are presented for two different community situations, projected enrollment decline and projected enrollment growth.

7.1.2.1 Enrollment Decline-Surplus Space

School districts characterized by substantial surplus capacity should consider the following options:

— Revised allocation of students
— Improved educational facility standards
— Increased number of multi-purpose school facilities
— Increased number of community-oriented facilities within the school
— School closing

These alternatives can be examined individually or in combination with one another.

Revised Allocation of Students. A major concern of many school administrators confronted with surplus space is the geographic distribution of this space. The surplus space may be concentrated in different grade levels or may be limited to a certain geographic area within the school system. There may, in fact, be significant shortages of space in some areas even though the district has an overall excess of capacity. This is a relatively common phenomenon, especially in those school districts where residential development has occurred rapidly and unevenly. In these situations several options may be possible. Reassignment of certain classes from the crowded schools to the less crowded schools may be the simplest step. Selected high school classes, for example, might be required to meet in elementary school teaching spaces. Another approach would involve grade reorganization. In a district characterized by a surplus of elementary school space and a shortage of secondary space, reorganization from a K-6, 7-9, 10-12 system to a K-8, 9-12 system might be desirable. The impact of any hypothetical reorganization can, of course, be tested using the Facility Component.

If the problem is one of geographic distribution, with certain sections of the district having surplus space while other areas are over-crowded, then changing attendance boundaries may be desirable. Here the primary trade-off will be between less crowded facilities and potentially higher transportation costs as defined in terms of additional bussing requirements or student travel time. The Geographic Component should help the user consider the feasibility of new attendance boundaries and their accompanying cost implications.

Improved Educational Facility Standards. Surplus space within the school system may permit improvement of certain standards and policies. For example, a school system may be able to relax its current double or staggered sessions policy, or reduce the number of students per teaching space. In this situation it is important to examine the extent to which the excess space is evenly distributed for all types of space and to determine whether selected facility types are still in short supply. Thus, the opportunity may exist for the conversion of surplus educational space into needed laboratory or vocational educational facilities.

A decision to increase the amount of space per child will have implications for the school system's operating budget. In most cases a reduction of the number of children per teaching space implies a need for additional teachers. Janitorial, supply, and other supporting services may also need to be expanded.

Increase the Number of Multi-Purpose School Rooms. Surplus space may allow a flexibility that was not previously possible. Teaching spaces may be used for study halls, student club rooms, special project rooms, and for various other student uses. Similarly, additional storage rooms, teachers' lounges, meeting rooms, and other spaces useful to the administration may become possible.

The advantages of this versatility must, of course, be evaluated in light of the ongoing overhead costs of these spaces as well as the cost of modernizing or rehabilitating them.

Increase the Number of Community-Oriented Facilities. School systems with considerable unused space may be in a position to serve the community in terms of more than just the education of children. Excess space may be appropriate for a variety of uses, such as senior citizen activities, day care centers, public interest group meetings, or even selected municipal functions such as libraries or health clinics.

Introducing this kind of mixed activity into an operating school raises questions about the effects on traffic, parking, and the educational environment. The use of surplus space for various community activities must not be allowed to interfere with the primary purpose — the education of students. Therefore, separate entrances, additional parking, and other such considerations must be carefully evaluated.

In situations where the community use of school facilities is possible, the issue of rent or fees must be considered. This will require an examination of the value of potential revenue if the going market price were to be charged versus the goodwill which might be obtained from a nominal rent or fee basis.

School Closing. When the surplus space within a school system reaches a certain level, the benefits associated with each of the above alternatives may be outweighed by the cost of maintaining one or more unnecessary schools. In such situations several difficult and interrelated questions must be addressed: How many schools to close; which schools to close; when to close them; and how to dispose of them?

How Many Schools to Close? The number of schools to be closed must be decided in light of many variables. These include:

— The amount of surplus space projected to exist and the user's confidence in that projection.

— The desired standards which are to apply to the remaining school space such as the maximum acceptable students per teaching space or square feet per student.

— The school's carrying costs in terms of both direct costs, such as insurance, maintenance, utilities, central administrative staff, and opportunity costs, such as potential sales revenue to the school system and the community benefits that could be realized if the school were converted to another use.

— The community concern associated with a school closing and the subsequent redrawing of attendance area boundaries.

Which Schools to Close? A related issue is the question of which schools to close. Each pertinent factor must be examined from the perspective of the school district and the overall community. Each existing school facility should be evaluated in terms of the following criteria:

— Structural conditions: What is the current condition of the building in terms of safety, usability, and amenities? What is the probability of significant problems, such as the need for a new furnace, major roof repairs, or other large scale maintenance costs?

— Structural flexibility: How readily could the building be modernized to serve alternative uses? Do the design and construction characteristics lend themselves to cost-effective rehabilitation?

— School operating costs: What are the current operating costs in terms of administrators, maintenance personnel, lighting and heating, and vandalism repair? Note that in deciding between closing two small schools versus one large school, the amount of space in question may be identical, but the associated operating costs may be quite different.

— School location: How will transportation times or distances and attendance area composition be affected by the school closing? Is the school in a neighborhood that is expected to have more, rather than fewer, children in future years?

— Site conditions: How much of an asset is the school site? What is its value as a recreation area, a neighborhood park, a community focal point? What potential does the site have for future school system needs?

— Immediate neighborhood concerns: How strongly do the neighboring citizens feel about the school? How would they react to alternative public or private uses?

— Land use flexibility: In light of zoning, access, surrounding activity, and available parking, how compatible would different uses be? Could the school be transformed to commercial or industrial use without causing major neighborhood disruption?

— Conversion potential: How easily could the school be converted to a new non-educational use given its facade, interior walls, and construction characteristics?

What demand for alternative uses exists in the area?

When to Close a School? The timing of any school closing is important. Consideration must be given to such factors as current and expected interest rates, rates of inflation, [illegible] well as the expected future characteristics of the immediately surrounding area.

Disposition. A fourth interrelated issue concerns the method selected for the disposition of a school. The school system must decide whether to sell, grant a long-term lease, or simply "mothball" an unnecessary school. This decision will be determined partly by the confidence the district has in its enrollment projections, and partly by its willingness to assume risks.

Once a decision to sell or lease the facility has been made, another issue will be that of price. The district may elect to maximize its revenue by selling to the highest bidder; it may choose to sell at a reasonable price to a worthy buyer; or it may donate the facility at a nominal fee or free. The district's fiscal situation and its community relations will have an important bearing on this decision. State laws pertaining to school district operations may also provide guidelines. Ultimately, the decision will be based on the costs of keeping the facility. Unlike a commercial or industrial property, carrying costs will not include local taxes. However, even if the school is boarded up, thus eliminating most utility and administrative costs, there will still be insurance, security, and outside maintenance requirements. Moreover, the carrying costs must be considered from the perspective of the community as well as the school district. A vacated school building may constitute a fire hazard or a blighting influence in the neighborhood. Finally, the costs in opportunity of not transforming the land and structure into some other use must be examined.

7.1.2.2 Enrollment Growth-Space Shortage

In those communities that continue to be characterized by enrollment growth, a different problem exists. While the issue is that of obtaining more space rather than eliminating excess space, many of the same questions must be resolved. A check list of considerations similar to those necessary in an enrollment decline situation is offered.

Revised Student Allocation. The first step should be to examine all schools throughout the system. A capacity shortage in one geographic area of the district or at one grade level in the district may be resolved through the reassignment of selected classes to a different school, reorganization of the grade groupings, and/or the redefinition of attendance boundaries.

The first solution may be the easiest but often the least satisfactory. Assigning selected elementary classes to a secondary school, or vice versa, may cause an important loss of school identity. The decision to reorganize the grade organization may be controversial and expensive. Converting a given school building from elementary to secondary purposes will probably require some new facilities, equipment, and support personnel. A third solution is a change in attendance boundaries. Longer student travel times or distances may require additional busses and drivers, not to mention parental cooperation. Though none of these solutions may be desirable, each should be explored.

Relaxed Educational Facility Standards. As previously observed, a greater number of children can be placed in a given school building simply by relaxing the space standards or changing the sessions policy. Thus, a decision to allow more children per teaching space (or less square footage per child) or a more intensive session policy, such as a staggered or double session or a twelve-month school year, might be considered. This option may have particular appeal in those districts characterized by a projected enrollment wave or bulge in selected grades, followed by subsequent enrollment declines.

In secondary school situations the problem may be partially relieved through the introduction of new instructional programs, such as work-study, "schools without walls," or some other activity that allows students to operate outside the building. Of course, these programs should be evaluated first on their instructional merit, and only then in terms of their space implications. In considering those implications, the user must be careful to examine whether the space requirements will be lowered throughout the school day, or only at certain times of the day. A work-study program that operates only during the afternoon may not represent a feasible solution.

Limit the Non-teaching Spaces Within the School. A third approach for accommodating increased enrollment would be an increase in the number of teaching stations and a decrease in the amount of space not used for actual teaching purposes. Thus, space previously used for study halls, meeting rooms, lounges, etc., by school personnel, and space used for non-student purposes would be reduced. Such activities would be required to locate elsewhere. This policy would, in effect, increase the school utilization rate, and hence the actual capacity of the school system.

Provide More Physical Space. If the above "non-structural" solutions appear inadequate, the provision of more physical space will become necessary. Again, several interrelated issues must be resolved: How much additional space, where, and what type?

How Much Additional Space? When a shortage of space exists, the question of how much capacity to provide must be addressed in a slightly different fashion than in the excess space situation. In the case of the potential school closings, one school is closed or two schools are closed, but rarely one and one-half schools. In most school growth situations a more continuous range of possibilities exists. Whether defined in terms of teaching spaces or square feet, a new school can be built in almost any size.

The amount of space necessary will depend upon the district's projected enrollment, desired standards and policies, current fiscal burden, and the degree to which the community is willing to shoulder any additional fiscal commitments.

Locating New Space. Where to locate new space will depend on the magnitude of the space problem and a variety of existing community conditions. At a minimum the following five options should be considered:

— Rehabilitation: In some situations the relatively simple process of school modernization will transform previously inadequate space into useful space. Rehabilitation is particularly recommended where a moderate rise in enrollment is anticipated on a temporary basis.

— Found Space: Existing vacant structures are proving to be useful, low-cost solutions. Store fronts, vacant office buildings, warehouses, supermarkets, or old train stations constitute just a fraction of the possible resources that may exist.

— Expansion of Existing School: The addition of several classrooms, a new wing, or new special facilities may be a solution. In this context mobile classrooms may be appropriate. The advantages of expanding an existing school are several: the availability of land, the availability of basic facilities such as office space, parking, or a gymnasium, and the availability of administrative staff. These advantages will, of course, have to be evaluated in light of the probable impact on the school site (especially recreation facilities and adjacent land uses) and the total school size. If the existing school is not well situated considering the geographic distribution of projected enrollments, the impact on transportation costs should be examined.

— New School on an Existing School Site: A variation to expanding existing schools is the building of a second school on the same site. This may provide the advantage of having a unique school on existing school land, with easy access to facilities in the adjacent school. This solution will require a relatively large site and may be more costly than expanding existing facilities. It may also suffer from the same locational shortcomings described before.

— New School on a Separate Site: Traditionally, the most common method of alleviating a severe shortage of space has been the construction of a new school on a separate site. Because of the ability to select a site that meets the needs of the new school, this approach may have more flexibility than others. However, the basic questions remain to be answered: how large a school, in what location and when.

Construction Type. The construction and the level of amenities will also have to be considered. Materials, landscaping, air conditioning, carpeting, and the many other decisions that go into a new building will depend principally on the school board's philosophy of education and financial situation. These decisions should also be influenced by the confidence surrounding the enrollment and fiscal projections. Where the school board is committed to the construction of traditional school buildings, characterized by rigid design and high quality materials, decisions should be based on forecasts with a great degree of associated certainty. On the other hand, where the school board and community are prepared to build flexible facilities that could be easily transformed to another use or demolished without great cost, less certainty in the enrollment and fiscal projections may be necessary.

In communities that are characterized by great uncertainty as to future conditions, mobile classrooms may provide a solution. While not always a panacea, as they have occasionally been promoted, mobile units can provide a flexible and relatively inexpensive supplement to existing facilities. Of course, potential building code restrictions, visual disharmony, limited internal versatility, maintenance problems, and other potential shortcomings may offset the advantages of this approach.

All of the above analysis will have to be made with an awareness that the projected conditions necessitating a change in facilities may not occur. Some users will want to account for this uncertainty by developing brackets or an envelope to surround their enrollment and fiscal projections. Using the approach outlined in Chapter 1, they will then consider the impact of the "worst" case, evidenced by high enrollments, high costs, and low revenues. Similarly the impact of the "most likely" and the "best" situations will have to be examined. Caution must be exercised. The use of high and low estimates may be very misleading if the brackets are built around a projection or curve that is fundamentally inaccurate.

Closing or building one or more schools is a challenging assignment. If a set of alternative plans is developed in a rigorous fashion, then hard to measure and evaluate trade-offs between social, educational, economic, and political values will be necessary. With few exceptions, no optimal solutions can be identified. Instead, based on intuition and judgement, the user must strive to identify several reasonable alternatives which can be critically evaluated using the Facility Planning System components.

7.2 Data Considerations

Users of the School Facility Planning System will have two categories of concern with regard to data. First, the specific data input requirements necessary to implement the system components must be considered. Determination will have to be made as to whether the data items or reliable substitutes are available within the district, and as to how they might be collected. Second, a more general understanding of community trends may be desired by school planners. This would include a general community profile or description against which specific projections could be made and specific plans drawn up. The following sections present a checklist of information relevant to school planning. Techniques for collecting, analyzing, and displaying the data are also suggested.

7.2.1 Required SFPS Information

Each of the procedural sections in the four components indicates specific data requirements. These items are summarized below, with brief indications as to their importance and probable sources.

— Students by Grade: A tabulation of the public school students for the current and past years provides basic trend information. Display of this data using a line or bar graph will heighten the visual impact of specific enrollment trends, and assist in selecting projection techniques. All the forecasting methods require total student enrollment for past years. The cohort survival technique requires specific grade data. Geographic analysis requires enrollment information by different regions and areas within the district.

— Vital Statistics: The number of births in a community will influence educational requirements for many years. This data is mandatory in the cohort survival technique. Vital statistics are usually recorded at the municipal or county level. Where the school system boundaries do not coincide with the city or county boundaries, adjustments will be necessary. These adjustments might be accomplished either manually or by machine by using the ratio between the school district and the recording level of government or by the actual allocation of births to the school district.

BIRTHS IN SMSA

DISTRICT	'70	'75	% Δ
A	3114	2199	-29
B	2738	1966	-28
C	7815	7271	-16

— Housing Type and Size: The kinds of dwellings in a community will affect the number of children. A profile of dwellings by type is required in the dwelling unit multiplier technique which rests on the premise that single-family homes attract different kinds of families than multi-family units. The number of dwellings by type may be determined from the United States Census. This figure can be adjusted monthly by using the Census Bureau's housing permit and housing start figures or using local building department records. Where the school district does not have the same boundaries as the local government, data adjustment problems will have to be resolved. Many medium and small school systems will be able to measure the number of single family dwellings from aerial photographs. Some municipal records may reveal the average number of bedrooms per dwelling type in different sections of the school system.

1970—1975
HOUSING CHANGE

Single Family Permits ________
Multi-Family Permits ________
Demolition Permits ________

Net Change ________

YIELD BY DWELLING TYPE

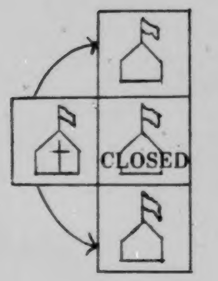
Age	Single Family	Garden Apts.
6-11	.346	.124
12-14	.200	.048
15-17	.200	.044
	.746	.216

— Housing Yield: The projected number of children per residential type is also required by the dwelling unit multiplier approach. The type, value, and age of dwellings will all influence the yield of public school children. Demographic, social, and economic factors will also have an important bearing. As discussed in the Enrollment Component the yield of children per dwelling may be determined empirically by using either a door-to-door or telephone survey in randomly selected neighborhoods. An approximation of this yield may also be determined from a sample of student records within the school district.

Zoning Type	Vacant Acres	Potential Dwellings
R-1	100	90
R-2	50	85
R-3	75	140

— Vacant Land: An estimation of the number of future dwellings, and hence children, can be facilitated by examining the available vacant land in each of the community's zoning categories. This will indicate the possible number of dwellings that could be constructed in each residential category. The probability of rezoning to higher residential densities must also be examined. This information is important in establishing upper growth limits for use in the non-linear time trend projections of dwellings or assessed valuation.

— Housing Built and Under Construction: Residential and tax base forecasts will also need trend data as to construction and demolition activity. In many suburban communities the amount of new housing expected in the future can often be estimated by reviewing recent subdivision plans and outstanding building permits. These records will also indicate the probable size and price of new housing.



— Parochial School Changes: The opening or closing of a private or parochial school may have a major impact on the public school system. The possibility of such an event must be examined when projecting future enrollments. If anticipated, a discrete shift upwards or downwards in the student forecast may be appropriate. The occurrence of such an event in the past must also be recognized to ensure that it has not caused the calculation of misleading enrollment trends.

— Major Growth Factors: The projection of student enrollments, dwellings or assessed valuation should reflect sensitivity to unique events that could severely alter historical development trends. Thus, a major highway project could induce substantial residential development or cause the demolition of a substantial number of dwellings. The implications of a major industrial contract, a building permit freeze, an energy crisis, and other unpredictable situations within the community must be recognized.

— Boundary Adjustments: Should a school district annexation or merger occur or if one has occurred in the recent past, special data may be required. Estimates of the students, dwellings, or tax base in the area prior to annexation may be necessary for continuity during the analysis period.

SUBJECT	STUDENTS
English I	500
English II	300
Social Studies	450
U.S. History	260

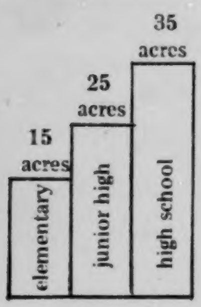
— Student Curricula: A projection of enrollments by subject area is important in determining space requirements by type of school space. This is particularly true in secondary school situations where different subject areas may have quite different room and/or special equipment implications. Historical subject area enrollment, other measures of student subject interest, and state requirements should all assist in determining the expected course enrollments necessary in the Facility Component.

— School Sessions Policy: The number of periods available for instruction each week is a necessary element in translating projected students into required space. Similarly, the possibility of a staggered session, double session, or twelve-month school year must be considered. Each of these policies will alter the need for physical space.

—Grade Organization Policy: A change in the grouping of grades into elementary, middle, and senior school categories may have a bearing on the calculation of required space. The board's willingness to alter the policy from the current grade organization should be considered.

— Facility Standards: Each school district must select its own standards in light of its unique characteristics and its educational philosophy. However, certain general rules may serve as points of departure for those school systems without specific standards in mind. Based on a survey of recent school planning materials, these are presented below. Where a range is indicated, the first number reflects typical existing values, whereas the second number reflects a desired standard for new construction.

SITE ACREAGE



Standard	Typical Values
Site Acreage	
Elementary	5-15 usable acres
Middle/Junior High	15-25 usable acres
High School	25-35 usable acres
Walking Distances	
Elementary	1/2 mile
Middle/Junior High	1 mile
High School	1 1/2 miles
Transportation Times	
Elementary	1/2-1 hr. twice a day
Middle/Junior High	1 hr. twice a day
High School	1 hr. twice a day
Student Capacity	
Elementary	250-650 students
Middle/Junior High	500-1,000 students
High School	700-1,500 students
Space Required	
Elementary	85-100 sq. ft./pupil (gross)
Self-contained	30-50 sq. ft./pupil
Flexible spaces	30-60 sq. ft./pupil
Open spaces	100-120 sq. ft./pupil
Gymnasium	40' x 60' — 80' x 120'
Middle/Junior High	95-110 sq. ft./pupil (gross)
Learning space	same as elementary
Special facilities	kitchen/typing/vocational
Gymnasium	75' x 90' — 100' x 100'
High School	100-130 sq. ft./pupil (gross)
Learning space	25-35 sq. ft./pupil
Flexible spaces	25-40 sq. ft./pupil
Open spaces	60-100 sq. ft./pupil
Gymnasium	100' x 110'
Swimming pool	75' x 45'
Special Facilities	
Pupils/Teaching Space	22-34 students
Administrative Space	Needs considered
Guidance Space	Needs considered
Conference Space	Needs considered
Instructional Materials Production Area	400 sq. ft. per elementary school 1200 sq. ft. per secondary school
Seminar Spaces	1/12 teachers, 350 sq. ft.
Teacher Office Space	1/2 teachers, 100 sq. ft.
Remedial Instruction Rooms	3/school, 200 sq. ft.

Library and Ancillary Space	1,000-2,700 sq. ft. per elementary school 2,000-5,000 sq. ft. per secondary school
Program Enrichment Areas	1/school, 1,200 sq. ft.
Small Project Areas	1/school, 350 sq. ft.
Carrels	15% of enrollment, 15 sq. ft.
Space for Programmed Instruction	1/school, 600 sq. ft.

The appropriate values for these standards will exhibit a tremendous degree of variation from one school system to another and will reflect the wide disparity of community needs, interests, goals, and resources. These values are presented merely to assist users in arriving at some initial figures. Perhaps the easiest way to specify standards during the planning process is to determine their present value within the district and then attempt to assess their adequacy.

— Existing Space: The Facility Component requires an inventory of available space, measured in teaching spaces or square feet. This should include space that is anticipated in the future as well as current space. The space type may be general (e.g., all classrooms) or specific (e.g., all large classrooms, all regular classrooms, etc.). The square feet may be measured in a gross category (e.g., all space in the building) or a net category (e.g., only space activity used for teaching).

— Facility Adequacy: Only usable or adequate space should be analyzed in the Facility Component. The level of school building adequacy can be measured from many perspectives. These include relatively objective measures, such as potential safety hazards and maintenance problems associated with the heating, wiring, ventilation, or waste disposal facilities. They may also include more subjective factors, such as the environmental impact on creativity concentration, and other learning attributes. It is generally recognized that a comprehensive measure of school facility adequacy will require the combined skills of architects, engineers, educators, and administrators. The costs of upgrading or repairing inadequate space must be examined if that space is to be considered available for future use.

— Additional School System Policies: A variety of additional policies must be considered in light of their space implications:

- — Student Drivers: What proportion of the students will want to or be allowed to drive their own vehicles to school? How much parking will be required?
- — Sports: What sports will be offered? Will tennis courts, a football field, a swimming pool or an ice hockey rink be necessary or desirable? Should parking, access, and seating capacity be designed to accommodate spectator volumes substantially in excess of the student body?
- — Food: Will a hot lunch be offered? If so, will it be catered or prepared on the premises? What proportion of the student body should be able to eat at a given time?
- — Amenities: Are carpeting, air conditioning, a media center, a theater, etc., considered necessary or desirable?
- — Special Use Location: Will special activities, such as machine shop training, automobile mechanics, and other activities, be taught at each school or at a central facility?
- — Community Use: Will the school be built so that it can readily serve adult education, senior citizens, and other community wide functions?

Many of these considerations will be important in establishing a desired utilization rate for each proposed school. If it is desired that there be substantial flexibility in teaching space so that unused classrooms are often available for meeting rooms, study hall, lounges, or storage, a low utilization rate (e.g., seventy-five or eighty percent) may be appropriate. Alternatively, if these needs have been considered separately and less flexibility is deemed important, a high utilization rate (e.g., ninety-five percent) may suffice.

— Site Characteristics: Existing and potential school building sites must be examined in terms of their positive and negative characteristics. Is the size sufficient for a school, including possible expansions? Does the topography lend itself to proper drainage, recreational opportunities, and easy construction? Are there wooded areas, vistas, or any other attributes that should be used to advantage? Is the site compatible with the existing and probable adjacent land uses? These questions, as well as the site's impact on student travel distance, must be resolved during the site selection procedures in the Geographic Component.

— Construction Costs: All potential rehabilitation or new construction projects must be evaluated in light of the probable construction costs per square foot. These will vary widely from region to region, based on the availability of building materials and the characteristics of the labor market. In most cases local architects/contractors will provide the best source for current and projected figures. A technique for projecting construction costs is presented in the Fiscal Component. An approach for examining possible variation in construction costs due to economy of scale factors is presented in the Handbook Introduction.

— Tax Base: In most cases the local tax base will directly impact the school system's capital, as well as operating, budget. Assessed valuation of real and personal property must be analyzed to determine probable bonding capacity and expected local tax revenue. Local income and sales taxes may also be important, depending on the tax structure.

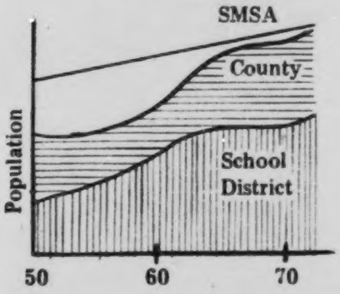
— Revenue: Historical revenues supporting the school district must be examined as to the amount and trend per source. In some instances the potential uses of these monies will be restricted to certain expenditure categories. The difference between taxes levied and actually collected should be analyzed. Also the past and possible changes in state allocation formulas should be studied. Federal support will be an important element in some districts.

— Expenditures: Historic expenditures by the district must be analyzed on a total cost and unit cost basis. Unique local conditions such as union demands and purchasing regulations must be considered as unit costs are projected. Educational policy regarding the desired number of teachers, administrators, support personnel, and supplies must also be examined in order to forecast total probable expenditures.

— School Capacity: The total existing space times the desired number of students per teaching station (or divided by the desired square feet per student) indicates the capacity of a school, or the number of students that can be accommodated. If a utilization rate is used by the district, it should be expressed in decimal form (i.e. less than one) and multiplied by the initial capacity to obtain an "effective" capacity. Individual school capacity information is necessary to implement the Geographic Component.

— School Distance: The average distance from all students living within small geographic areas or grids in the district to each school is necessary to implement the Geographic Component. This information should be calculated for the center of student population within each grid and may be estimated by using a land use map, street map or aerial photography. Distance can be expressed in terms of travel miles, travel time, or travel cost.

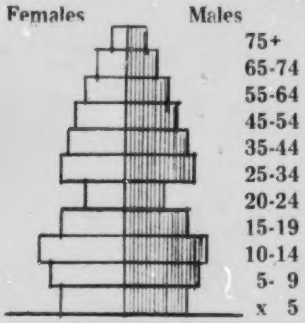
7.2.2 General School Planning Information



In addition to those items required to implement the various system components, further information may be desired. In some cases this additional data will contribute to better estimates of the previously described variables. In other cases the information will be useful in gaining a general understanding of the community; how it is changing over time and how it compares to adjacent communities, the state, and the nation. Familiarity with the broad social and economic trends that influence school district conditions should lead to the formulation and adoption of a better plan.

— Total Population: The total population constitutes a basic measure of a community. This information is available every ten years from the United States Census at the county, municipal, census tract, and block level. Specific tabulations for school systems can be obtained from the National Center for Educational Statistics. Local planning offices and universities may have this information as well as inter-census year estimates.

— Age Composition: An understanding of the age distribution of the population is

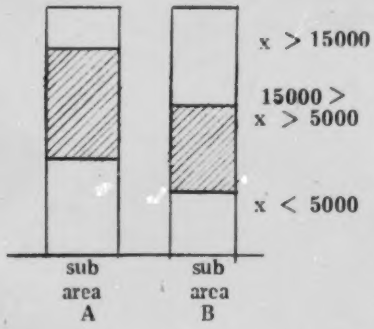


important. Population "pyramids" are often used to designate this distribution. Females of childbearing age, school-age children, and pre-school children are, of course, the most important cohorts. Age profiles by sub-geographic areas within a school system may be helpful in identifying those neighborhoods likely to increase or decrease their percentage of students.

— Minority Group Composition: The number and location of racial minorities are important to the school system. Racial or ethnic shifts may portend changes in birth rates and may necessitate revisions in attendance area boundaries. Minority population data may be determined from the decennial or local school district census, or inferred from local health department records. Techniques for projecting the racial composition of students are described in the Enrollment Component.

— Demographic Characteristics: A variety of information regarding income, education, occupation, head of household, and other socio-economic characteristics is available on a sample basis from the United States Census. Often it can be supplemented by a local survey. Analysis of these factors may provide indications as to the kind of people who live in and are moving into a community. With caution, some inferences may be drawn as to the likelihood of future families sending their children to private schools and/or supporting public education. Religious data is not available from the United States Census. Community trends that might influence the proportion of children attending parochial schools must be determined from local data.

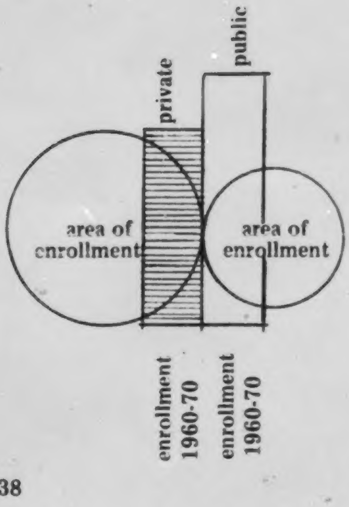
RESIDENTIAL ASSESSED VALUATION BY SUB AREA



— Housing Value: The price of dwellings will directly affect the school district. Communities characterized by more costly housing will typically be chosen by older, wealthier families with older children. Less expensive subdivisions will tend to accommodate younger families with younger children. Housing value also affects the tax base. In communities where reappraisal occurs on a routine basis, rising residential property values will contribute to a higher tax base. They may also indirectly promote housing turnover as retired families are pressured to seek communities with lower taxes.

— Housing Age: In many communities the age of housing may be directly correlated with the number of children. Large subdivisions characterized by similar dwellings typically attract similar families. Over time, the demographic mix of the subdivisions broadens as dwellings change hands. However, during the early years (the first ten to fifteen), a subdivision may be characterized by a very narrow age distribution of families and children. Knowledge of housing value and age factors should contribute to a better understanding of probable migration trends.

— Student Drop-Outs: Historical information concerning drop-out rates, retention rates and intra-district transfers between schools should be examined if readily available. Major shifts in these rates may imply demographic and migratory trends useful in selecting an enrollment projection technique, or may modify an existing forecast. The cumulative or net effect of these shifts will be reflected in the historical cohort survival rates.



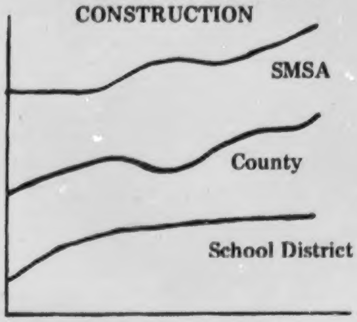
— Student Commuters: Some school districts accept students from outside the school district upon payment of extra tuition fees, or as part of a [illegible]ary program. In certain school systems, the number of non-resident commuters may be large enough to have significant facility space implications. These students may constitute a good revenue source to the school district. They may also be viewed as a first area in which cutbacks may be made when space shortages are expected.

— Private School Enrollment: Historical enrollment levels will often be desirable for private/parochial schools in the district's vicinity. Because these schools will usually not adhere to public school district boundaries, information should be collected for private and parochial schools in a considerably larger service area. Some private school systems may have records that allow identification of the public school system in which the students reside. Gross private school enrollment statistics are also available on a census tract, municipality, or county basis in the decennial census reports. The trend information may be useful in selecting a forecasting technique and evaluating the forecast results.

— General Plan: The comprehensive, master, or general plan in a community may provide valuable insights into the future housing supply. Especially where there is no zoning or a record of continuing rezoning, this document may be the best predictor of the community's residential holding capacity. Where available, this information should be examined in conjunction with the inventory of vacant land within the district.

— Critical Development Factors: In those communities where growth management and land use controls have become an issue, additional considerations may be necessary. State land use regulations and state and regional plans may restrict local community activity in flood plain, wetland, mountainous, and other "critical" areas. Environmental concerns may also result in moratoria, air pollution restrictions, and other growth regulating limitations.

PROJECTED HOUSING CONSTRUCTION



— Regional Housing Market: In addition to factors influencing the supply of residential land, consideration must be given to the demand for housing. The probability of new housing being built and sold will be directly affected by population and economic trends within the region. The local realtors association, chamber of commerce, and regional planning agency may provide insight. Probable shifts in the school district's proportion of the regional market must be considered.

— Employment: Population growth within a region is usually correlated with the region's economic health. Employment trends constitute the most common measure of economic conditions. Unlike housing, the distribution of employment centers within a school system is not usually a critical factor, except to the extent that it generates automobile traffic. Employment centers located within a school district may be major sources of real property tax, sales tax, manufacturing tax, or other kinds of income. Employment trends within the region will have an important, though hard to measure impact on migration patterns. Employment information may be gathered from United States Census reports, County Business Patterns reports, the State Division of Employment Security, and local business development groups.

— Industrial-Commercial Land: A second measure of local economic conditions is the amount of industrial and commercial acreage that is developed annually. Local planning, real estate, and utility firms should have this information available on a regional basis. Recalculations for the school system will typically be necessary. The land absorption rates will indicate how fast the economy of the community is changing, the probable impact on assessed valuations, and the extent to which the community's general plan remains relevant.

— Additional Economic Indicators: A variety of additional statistics will usually be available at the metropolitan, county, or municipal levels. Retail sales information is often available from those jurisdictions collecting sales taxes. Bank assets and related financial data may be obtained from the federal reserve bank and the state banking regulatory commission. Business licenses, inventory assessments, bankruptcies, and tax delinquencies may be available locally. Collectively, these trends will suggest the direction of the local economy.

— Voter Attitude: The power of the voters to control school finances will vary widely, depending on state enabling legislation. The record of recent tax levy and bond issue attempts and the reasons for their success or failure should be studied early and carefully in the planning process. Old newspapers, the Board of Elections Office, and local governmental officials may provide valuable insight.

— Tax Effort: The effective tax in the school system should be compared to that of surrounding communities. Differences in assessed valuation should be accounted for. An attempt should be made to understand why the school district spends more or less per pupil than surrounding districts. This may indicate the desirability of adjusting the state allocation formula or raising local taxes.

SCHOOL DISTRICTS

	A			B		
Year	Av.	Rate	Yield	Av.	Rate	Yield

— Institutional Cooperation: Review should be made of cooperative efforts between the school system and other local institutions. These might include the sharing of municipal workers, such as nurses, social workers, and police, and the sharing of transit authority busses. Relations between the local press and the school system should be examined.

—Citizen Concerns: Major community issues surrounding local education should be identified. Review of past school board minutes and of previous school board election campaigns should provide insight. An understanding of community aspirations should enable the creation of a more relevant and acceptable school plan.

7.3 Systems Maintenance

Like many planning activities, school facility planning is most successful when it is undertaken as a continual process. Those school systems that prepare and adopt a long-range master plan and then do nothing to monitor and revise that plan may encounter difficulties. Particularly in an environment characterized by a high degree of uncertainty, every long-range plan should be re-examined periodically so that new information, assumptions, and standards are explicitly considered. In fact, in those situations where the School Facility Planning System has not revealed an obvious need for a new facility or facility closing, it may make sense to postpone final adoption of a plan until new enrollment, cost, and/or revenue information become available. At a minimum, each school system should devote several days each year to a re-examination of the plan in light of new information.

7.3.1 Preliminary Review

When a decision is made to re-examine a plan, the first step will be to compare previously projected data with actual new information. After the difference and hence the short-comings of the projection have been identified, an effort must be made to understand the sources of this forecasting error. In certain cases, these differences may result from a major unforeseen event. Thus a new shopping center or residential complex, of which the user was unaware at the time of the first plan, may explain higher enrollment levels or a higher tax base than was previously expected. In other cases, the difference will result not so much from a unique event, but from an inadequate set of initial assumptions. The actual grade survival rates, growth in dwelling units, and tax base should be examined with this in mind.

7.3.2 New Projections

Based upon the preliminary examination a set of new assumptions should be made for each of the System's components. Specific shifts in actual enrollment or housing permits and general shifts in zoning or economic activity should provide the basis for revising the Enrollment Component analysis. New school board members, new issues, and changes in existing facility conditions should provide the basis for a re-examination of the Facility Component. New cost and revenue trend information should provide the basis for a re-examination of the Fiscal Component. A new road or a shift in student residential patterns may justify review of the attendance boundaries by the use of the Geographic Component.

Once a new set of independent projections has been generated, the relevance of the existing facility plan can be tested. In many cases, the difference between the new and old projections will not justify a major revision. In other cases, new alternatives and a new plan may be justified. Even where the main elements of the plan are still appropriate, some minor adjustments in terms of timing may be necessary For example, the new projection might continue to support the need for a new high school, but indicate that a faster or slower construction schedule was desirable.

7.3.3 Record-Keeping

Those school districts interested in using the System on a recurring basis should consider modifications to their record-keeping procedures which would facilitate the System's use. These modifications need not take the form of a major project. In some cases, a simple written or telephone request to certain government agencies may be sufficient. In other situations, a more detailed study may be appropriate.

The specific record-keeping changes will vary with each school system. For example, in communities where school system boundaries are coterminous with the municipal government boundaries, vital statistical information may not be a significant problem. In areas where the boundaries are divergent, efforts might be initiated to record births by school system on an ongoing basis. This could involve providing a list of school system addresses to the local government's vital statistics department with the request that it summarize births for the school system, or a copy of all births in the municipal jurisdiction might be obtained by one of the school system's clerks.

With only minor record-keeping modifications, a more complete picture of migration trends may be possible. The school system's personnel office may be willing to keep a summary sheet of selected data for new students entering and leaving the system. Information recorded would include the grade, the date of the move, the location from which or to which the student was moving, and the reason for the move.

Some communities monitor the number of pre-school children by age and public/private school intent. If the school system is small enough, a continuing review of real estate listings and housing ads will indicate housing turnover and new families that are moving into the area. These families can be provided with an information packet, through Welcome Wagon or some similar organization with a form to be returned to the school district. This activity may be unreasonably time-consuming for a large school system, but, where possible, it will give a profile of pre-school children, as well as initiate interest in the school system.

GLOSSARY

The following terms are used frequently throughout the School Facility Planning System documentation. In some cases the meaning may differ slightly from that commonly used by educational administrators.

Adequate Space — All existing facility space considered adequate for teaching purposes, and requiring no financial investment other than routine maintenance costs. In the Facility Component, adequate space is compared with required space to determine the expected space deficit or surplus.

Assessed Valuation — The real property tax base against which a tax rate is applied to yield local property tax revenue. Assessed valuation varies with the level and quality of urban development and local assessing policy. Techniques whereby it may be forecast are described in the Fiscal Component.

Asymptote — The upper (or lower) limit of a community, whether measured in terms of population, dwellings or assessed valuation. Some of the projection techniques used in the Enrollment and Fiscal Components allow the user to establish this upper (or lower) limit.

Attendance Area — A geographic area within a school district from which all public school children attend the same school. The Geographic Component is designed to help draw up attendance area boundaries.

Alternative School — A "non-school" approach oriented to students that are not interested in a traditional high school format (e.g., Philadelphia's Parkway Program or Chicago's Metro High School). This may be an important consideration in calculating "effective enrollment" in the Facility Component.

Bonding Capacity — The maximum bonded indebtedness permitted of a school district under state law. This may be calculated on a gross basis, usually as a percent of total assessed valuation, or on a net basis after existing outstanding indebtedness is considered.

Capacity — The number of students that can be accommodated in a school given its physical size and design, and the policies and standards endorsed by the school board.

Cohort Survival — A technique for projecting student enrollment by calculating the "survivors" from one grade to the next. Also known as the "Grade Succession" or "Grade Aging" technique.

Component — A major sub-system within the School Facility Planning System. The four analytical components are designed to be used independently or together, depending upon the needs of the user.

Confidence Interval — A range of values within which a projected variable such as enrollment or assessed valuation will fall a large percentage of the time. Also known as a confidence band, limit or envelop, this concept is very important in making long-range forecasts.

Course Enrollment — The average number of courses taken daily by individual students in a particular subject area multiplied times the number of students in the school or district. As described in the Facility Component, this variable is used to calculate "effective enrollment."

Demand — An expressed need or request for a commodity. A major objective of the School Facility Planning System is to help school districts forecast the future demand for public education and derive the facility implications.

Dwelling Unit Multiplier — A technique for projecting student enrollment based on a projection of residential dwellings and expected yield of school children per dwelling. Appropriate in rapidly growing districts.

Economy of Scale — A measure of the unit cost savings for land, labor, and materials that may be achieved by building a larger rather than smaller facility. The concept must be used carefully because the contribution to educational quality of any two school facilities will rarely be the same, and hence comparing their costs may be misleading.

Effective Enrollment — The number of students expected to be physically in attendance at a specific point in time during a typical school week. The desired teaching station or square foot standard applied against effective enrollment in the Facility Component yields a measure of required space.

Extended School Day/Year — A program for increasing the capacity of a school facility by reducing the number of children attending school at any specific time. The impact of staggered or double sessions, or a 12 month school year can all be "tested" using the Facility Component.

Facility — Any school space or building used to serve students. The user of the Facility Component may consider the need for any kind of space measured in terms of teaching spaces or square feet.

Found Space — Building space "discovered" within an existing school or "non-school" building (e.g., warehouse, industrial plant) for teaching purposes. An important consideration in formulating alternative facility plans.

Gompertz Curve — A special type of logistics curve in which the rate of change is decreasing exponentially. This function appears as an "S" curve, and has the form $P_{t+n} = \log K + (\log a)(\log/r^n)$. It may be used in the computer-based version of the Enrollment and Fiscal Components.

Grade Organization — The manner in which a school system assigns its grades to elementary and secondary schools (e.g., 4-4-4, 6-2-4, 6-3-3, etc.).

Grid — The smallest geographic area for which dwellings and students are forecast in the System. Also known as "areas," grids may have irregular or rectangular boundaries. Data must be assembled by grid to support the Geographic Component.

Home-Base School — A school system in which the building is the "Home-Base" only for students' activities. High schools with work study programs or a "School Without Walls" are Home-Base schools with the potential for an enlarged student capacity.

Joint Occupancy — A method for sharing the cost of a facility between a public school district and some other organization (e.g., a city government) by sharing the space. An option to be considered in drawing up a fiscal plan and facility plan.

Linear Program — A mathematical technique which allows the value of a linear function to be minimized or maximized, subject to certain constraints. Linear programming is used in the Geographic Component to assign students to schools so that transportation costs are minimized.

Logistics Curve — An "S" shaped curve resulting from an exponential function of the form $P_{t+n} = K/l + c^{a+bn}$ Techniques using this function are found in the Enrollment and Fiscal Components.

Module — A discrete set of tasks in the computer version of the System. Typically a component can be categorized in terms of several modules.

Open Campus — An increasingly popular concept that permits high school students to move freely inside and outside of school when not scheduled for a course. Adoption of an open campus policy will have implications for required teaching spaces, libraries, lounges, and other school space.

Periods Per Course — The average number of periods per course each student attends in a typical school week. This factor is used to help determine effective enrollment for a given subject area in the Facility Component.

Periods Per Day — The number of periods each day during which classes are held. As reviewed in the Facility Component, this factor will contribute to the calculation of effective enrollment.

Planning Period — The future time period over which forecasts will be made, and for which facility size and location decisions will be made. The planning horizon is the farthest year into the future for which facility planning will be conducted.

Policy — A course of action adopted by the school district which directly or indirectly impacts facility planning (e.g., staggered sessions, grade organizations, etc.).

Projection — A statement of conditions expected to exist in the future based on a set of explicit assumptions. The terms "projection" and "forecast" are used interchangeably throughout the documentation.

Ratio Method — A technique for projecting enrollment whereby students are estimated as a function of a projected ratio multiplied times an independently derived projection for a larger jurisdiction (e.g., county, state, or national).

Region — A geographical homogeneous sub-area of a school district for which independent projections are made. The typical district can be divided into two to four "regions" which in turn can be broken into as many as 30 "grids."

Regression Analysis — A statistical measurement of the form and strength of relationships between variables. Linear and exponential regression techniques may be used in the Enrollment and Fiscal Components for projection purposes.

Resource Center — A particular facility such as a library, art or vocational building which may attract students from more than one separate school. A consideration in developing a facility plan.

School District — A government entity engaged in the operation of public schools. The term is used synonymously with "school system," "local educational authority (LEA)," and "the user" throughout the documentation.

School Size — The desired maximum capacity or number of students per school type (e.g., elementary schools—400 children, high schools—1500 children, etc.). This standard may have an important bearing on a facility plan.

Square Feet — One of the measures of school capacity that may be used in the Facility Component. Gross or net square feet per student may be used. See Teaching Station.

Standard — A measure or criterion that directly or indirectly impacts facility planning (e.g., desired square feet per pupil, desired pupils per teaching station, etc.) as adopted by the school district.

Subject Area — Any course or combination of courses for which the effective enrollment is to be calculated in the Facility Component. In general, a particular subject area should be defined in light of similar space type requirements (e.g., regular classrooms, large classrooms, etc.).

Survey — The traditional approach whereby administrators inventory and evaluate school buildings, curriculum, and instructional techniques. The School Facility Planning System does not replace the need for comprehensive school surveys.

Teaching Station — Any classroom or learning space as defined by a school district, and used in measuring capacity in the Facility Component. See Square Feet.

Transportation Costs — A measure of the distance, time or money associated with transportation. The Geographic Component assists in the design of attendance boundaries, or the evaluation of school sites by indicating the configuration which will best reduce transporation costs.

Utilization Rate — The average percent of educational space which is occupied at any time during a typical school day. This factor is used to permit increased flexibility in determining space requirements in the Facility Component.

Uncertainty — A condition that characterizes all planning activity, especially where long-range forecasts or projections are involved. The School Facility Planning System has been designed to assist administrators in explicitly considering the reality of uncertainty.

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A. General School Planning
B. Capital Planning, Budgeting and Quantitative Methods
C. Enrollment Analysis
D. Facility Analysis
E. Fiscal Analysis
F. Geographic Analysis

With few exceptions the bibliography does not include general planning references, articles in "popular" educational journals, foreign literature or specific school plans. Educational Resource Information Center numbers (ERIC) and Dissertation numbers have been included where available.

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LIST OF FORMS

These 37 forms are presented in the final section of this handbook.

TITLE

Chapter 2 ENROLLMENT COMPONENT

Form	A	Cohort Survival Technique — Grade Survival Rate Circulation
	B	Cohort Survival Technique — Birth Survival Rate Estimation
	C	Cohort Survival Technique — Initial Grade Enrollment Forecast
	D	Cohort Survival Technique — Enrollment Forecasts
	E	Time Trend Projection — Type A
	F	Time Trend Projection — Type B
	G	Time Trend Projection — Type C
	H	Ratio Technique
	I	Dwelling Unit Multiplier Technique — Historic Yield Estimates: Single-Family Units
	J	Dwelling Unit Multiplier Technique — Forecast of Yields
	K	Dwelling Unit Multiplier Technique — Forecast of Dwellings and Enrollment
	L	Enrollment Forecast by Grade
	M	Sub-Geographic Region Forecasts
	N	Small Area Forecasts
	O	Small Area Forecasts — Adjustment Computation
	P	Small Area Forecasts — Area Enrollment Totals

Chapter 3 FACILITY COMPONENT

Form	A	Future Facility Needs
	B	Course Per Student and Periods Per Course

Chapter 4 FISCAL COMPONENT

Form	A	Summary of Expenses
	B	Summary of Revenues
	C	Summary of Bonding Capacity
	D	Summary of Fiscal Projections
	E	Building Cost
	F	Total Employees
	F.1	Total Employees/Alternative
	G	Salaries and Benefits
	H	Supplies and Services
	I.1	Linear Growth or Decline
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	I.3	Nonlinear Decline
	J	Real Property Tax Revenue
	K	Sales and Other Local Taxes
	L	Activities Fees
	M	Earnings on Investments
	N	State Aid Based on Enrollment
	O	State Aid Based on Assessed Valuation
	P	Federal Revenue

Chapter 2 ENROLLMENT COMPONENT

Form	A	Cohort Survival Technique — Grade Survival Rate Circulation
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	D	Cohort Survival Technique — Enrollment Forecasts
	E	Time Trend Projection — Type A
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	G	Time Trend Projection — Type C
	H	Ratio Technique
	I	Dwelling Unit Multiplier Technique — Historic Yield Estimates: Single-Family Units
	J	Dwelling Unit Multiplier Technique — Forecast of Yields
	K	Dwelling Unit Multiplier Technique — Forecast of Dwellings and Enrollment
	L	Enrollment Forecast by Grade
	M	Sub-Geographic Region Forecasts
	N	Small Area Forecasts
	O	Small Area Forecasts — Adjustment Computation
	P	Small Area Forecasts — Area Enrollment Totals

FORM A: COHORT SURVIVAL TECHNIQUE— GRADE SURVIVAL RATE CALCULATION

YEAR	1969-70		1970-71		1971-72		1972-73		1973-74		1974-75	
GRADE	ENROLLMENT											
12	765	.934	735	.962	684	.922	712	.930	661	.923	647	
11	787	.960	711	.923	772	.932	711	.931	701	.946	669	
10	741	.972	836	.959	763	.977	753	.978	707	.942	646	
9	860	1.03	796	1.01	771	.985	723	.988	686	.982	648	
8	771	.972	767	.991	734	1.01	694	.988	660	.978	591	
7	789	.988	741	1.01	690	.960	668	.942	604	.960	572	
6	750	.984	684	.989	696	.976	641	.972	596	.991	571	
5	695	.981	704	.947	657	.958	613	.957	576	.960	578	
4	718	.976	694	.980	640	.979	602	.950	602	.973	499	
3	711	.988	653	.970	615	.980	634	.957	513	.941	464	
2	661	.956	634	.966	647	.971	536	.961	493	.926	462	
1	663	.874	670	.847	552	.852	513	.871	499	.994	494	
K	767		652		602		573		497		479	

973-74		1974-75									Average Survival Rates
661	.923	647									.934
701	.946	669									.938
707	.942	646									.966
686	.982	648									.999
660	.978	591									.988
604	.960	572									.972
596	.991	571									.982
576	.960	578									.961
602	.973	499									.972
513	.941	464									.967
93	.926	462									.956
99	.994	494									.888
97		479									

FORM B: COHORT SURVIVAL TECHNIQUE– BIRTH SURVIVAL RATE ESTIMATION

		1	2	3	4	5	6
	YEAR (t)	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75
1	INITIAL ENROLLMENT	767	652	602	573	497	479
	YEAR (t - a)	1964-65	1965-66	1966-67	1967-68	1968-69	1969-70
2	BIRTHS	15,039	12,302	10,203	8,953	7,100	8,870
3	B.S.R.	.051	.053	.059	.064	.070	.054

AVERAGE BIRTH - SURVIVAL RATE	.0585

FORM C: COHORT SURVIVAL TECHNIQUE– INITIAL GRADE ENROLLMENT FORECAST

		1	2	3	4	5	6
	YEAR (t - a)	1970-71	1971-72	1972-73	1973-74	1974-75	
1	BIRTHS	8130	7829	8064	7504	6871	
	YEAR	1975-76	1976-77	1977-78	1978-79	1979-80	
2	enrollment (e)	476	458	472	439	402	

	4	5	6	7	8	9	10
72	1972-73	1973-74	1974-75				
	573	497	479				
67	1967-68	1968-69	1969-70				
03	8,953	7,100	8,870				
	.064	.070	.054				

VERAGE BIRTH - SURVIVAL RATE .0585

	4	5	6	7	8	9	10
3	1973-74	1974-75					
	7504	6871					
8	1978-79	1979-80					
	439	402					

FORM D: COHORT SURVIVAL TECHNIQUE— ENROLLMENT FORECASTS

				1	2	3	4
1	YEAR	AVERAGE SURVIVAL RATE	current year	1975-76	1976-77	1977-78	1978-79
	GRADE						
2	12		647	625	566	548	500
3	11	.934	669	606	587	535	511
4	10	.938	646	626	570	545	528
5	9	.966	648	590	564	547	544
6	8	.999	591	565	548	545	453
7	7	.988	572	555	552	458	413
8	6	.972	571	568	471	425	409
9	5	.982	578	480	433	417	426
0	4	.961	499	451	434	443	382
1	3	.972	464	447	456	393	391
2	2	.967	462	472	406	404	389
3	1	.956	494	425	423	407	419
4	K	.888	479	476	458	472	439
	TOTAL ENROLLMENT		7320	6886	6468	6139	5804

2	3	4	5	6	7	8	9	10
1976-77	1977-78	1978-79	1979-80					
566	548	500	477					
587	535	511	495					
570	545	528	526					
564	547	544	453					
548	545	453	408					
552	458	413	398					
471	425	409	418					
433	417	426	367					
434	443	382	380					
456	393	391	376					
406	404	389	401					
423	407	419	390					
458	472	439	402					
468	6139	5804	5491					

FORM E: TIME TREND PROJECTION—TYPE A

		1	2	3	4	5	6	7	8	9	10	11
1	SCHOOL YEAR						1970-71	1971-72	1972-73	1973-74	1974-75	
2	T						1	2	3	4	5	
3	$\bar{T}$	3										
4	$T - \bar{T} = t$						–2	–1	0	1	2	
5	t^2						4	1	0	1	4	
6	Σt^2	10										
7	ENROLLMENT (E)						9277	8823	8373	7795	7320	
8	$\bar{E}$	8318										
9	$E \cdot t$						-18554	-8823	0	7795	14640	
10	$\Sigma E \cdot t$	–4942										
11	$\Sigma E \cdot t / \Sigma t^2 = B$	-494										
12	$B \cdot \bar{T}$	-1482										
13	YEAR						1970-71	1971-72	1972-73	1973-74	1974-75	1975-76
14	T						1	2	3	4	5	6
15	$\bar{E} - (B \cdot \bar{T})$						9800	9800	9800	9800	9800	9800
16	$B \cdot T$						–494	-988	-1482	–1976	–2470	-2964
17	ENROLLMENT ($\hat{E}$)						9306	8812	8318	7824	7330	6836

HISTORICAL DATA

8	9	10	11	12	13	14	15	16	17	18	19	20
1972-73	1973-74	1974-75										
3	4	5										
0	1	2										
0	1	4										
8373	7795	7320										
0	7795	14640										
1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80					
3	4	5	6	7	8	9	10					
9800	9800	9800	9800	9800	9800	9800	9800					
-1482	-1976	-2470	-2964	-3458	-3952	-4446	-4940					
8318	7824	7330	6836	6342	5848	5354	4860					

ISTORICAL DATA

PLANNING HORIZON

FORM F: TIME TREND PROJECTION—TYPE B

		1	2	3	4	5	6	7	8	9	10	11
1	SCHOOL YEAR						1970-71	1971-72	1972-73	1973-74	1974-75	
2	T						1	2	3	4	5	
3	$\overline{T}$	3										
4	$T-\overline{T}=t$						–2	–1	0	1	2	
5	t^2						4	1	0	1	4	
6	Σt^2	10										
7	ENROLLMENT (E)						8995	9399	9552	9745	9875	
8	MAXIMUM E (K)	10,500										
9	K / E						1.167	1.117	1.099	1.077	1.063	
10	K/E – 1						.167	.117	.099	.077	.063	
11	ln (K/E–1) = Y						–1.79	–2.15	–2.31	–2.56	–2.76	
12	$\overline{Y}$	-2.314										
13	$Y \bullet t$						+3.58	+2.15	0	–2.56	-5.52	
14	$\Sigma Y \bullet t$	-2.35										
15	$\Sigma Y \bullet t / \Sigma t^2 = B$	-.235										
16	$B \bullet \overline{T}$	-.705										
17	SCHOOL YEAR						1970-71	1971-72	1972-73	1973-74	1974-75	1975-76
18	T						1	2	3	4	5	6
19	$\overline{Y} - (B \bullet \overline{T})$						–1.609	–1.609	-1.609	–1.609	–1.609	-1.609
20	$B \bullet T$						–.235	–.470	–.705	–.940	–1.175	-1.410
21	$\hat{Y}$						–1.844	–2.079	-2.314	–2.549	-2.784	-3.019
22	K/E – 1						.159	.125	.099	.078	.062	.049
23	K/E						1.159	1.125	1.099	1.078	1.062	1.049
24	ENROLLMENT ($\hat{E}$)						9060	9333	9554	9740	9887	10,010

HISTORICAL DATA

	8	9	10	11	12	13	14	15	16	17	18	19	20
72	1972-73	1973-74	1974-75										
	3	4	5										
	0	1	2										
	0	1	4										
9	9552	9745	9875										
7	1.099	1.077	1.063										
7	.099	.077	.063										
5	-2.31	-2.56	-2.76										
15	0	-2.56	-5.52										
2	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80					
	3	4	5	6	7	8	9	10					
	-1.609	-1.609	-1.609	-1.609	-1.609	-1.609	-1.609	-1.609					
	-.705	-.940	-1.175	-1.410	-1.645	-1.880	-2.115	-2.350					
	-2.314	-2.549	-2.784	-3.019	-3.254	-3.489	-3.724	-3.959					
	.099	.078	.062	.049	.039	.031	.024	.019					
	1.099	1.078	1.062	1.049	1.039	1.031	1.024	1.019					
	9554	9740	9887	10,010	10,106	10,184	10,254	10,304					

HISTORICAL DATA **PLANNING HORIZON**

FORM G: TIME TREND PROJECTION—TYPE C

							HISTORICAL DATA					PLA
		1	2	3	4	5	6	7	8	9	10	11
1	SCHOOL YEAR						1970-71	1971-72	1972-73	1973-74	1974-75	
2	T						1	2	3	4	5	
3	$\overline{T}$	3										
4	$T - \overline{T} = t$						-2	-1	0	1	2	
5	t^2						4	1	0	1	4	
6	Σt^2	10										
7	ENROLLMENT (E)						10115	9587	8795	7962	7321	
8	MINIMUM E (M)	6500										
9	E – M = E'						3615	3087	2295	1462	821	
10	MAXIMUM E (K)	10,500										
11	K – M = K'	4000										
12	K' / E'						1.107	1.296	1.743	2.736	4.872	
13	K'/E' – 1						.107	.296	.743	1.736	3.872	
14	ln (K'/E'–1) = Y						–2.23	–1.22	-0.30	.55	1.35	
15	$\overline{Y}$	-1.85										
16	$Y \bullet t$						4.46	1.22	0	.55	2.70	
17	$\Sigma Y \bullet t$	8.93										
18	$\Sigma Y \bullet t / \Sigma t^2 = B$	.893										
19	$B \bullet \overline{T}$	2.679										
20	SCHOOL YEAR						1970-71	1971-72	1972-73	1973-74	1974-75	1975-76
21	T						1	2	3	4	5	6
22	$\overline{Y} - (B \bullet \overline{T})$						–4.529	–4.529	–4.529	–4.529	–4.529	–4.529
23	$B \bullet T$						.893	1.786	2.679	3.572	4.465	5.358
24	$\hat{Y}$						-3.636	-2.743	-1.850	–.957	–.064	.829
25	K'/E' – 1						.027	.065	.157	.383	.94	2.3
26	K' / E'						1.027	1.065	1.157	1.383	1.94	3.3
27	E'						3895	3756	3457	2892	2062	1212
28	ENROLLMENT ($\hat{E}$)						10,395	10,256	9957	9392	8562	7712

HISTORICAL DATA			PLANNING HORIZON									
8	9	10	11	12	13	14	15	16	17	18	19	20
1972-73	1973-74	1974-75										
3	4	5										
0	1	2										
0	1	4										
8795	7962	7321										
2295	1462	821										
1.743	2.736	4.872										
.743	1.736	3.872										
-0.30	.55	1.35										
0	.55	2.70										
1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80					
3	4	5	6	7	8	9	10					
-4.529	-4.529	-4.529	-4.529	-4.529	-4.529	-4.529	-4.529					
2.679	3.572	4.465	5.358	6.251	7.144	8.037	8.93					
-1.850	-.957	-.064	.829	1.722	2.615	3.508	4.401					
.157	.383	.94	2.3	5.6	13.5	33.4	82.1					
1.157	1.383	1.94	3.3	6.6	14.5	34.4	83.1					
3457	2892	2062	1212	606	276	116	48					
9957	9392	8562	7712	7106	6776	6616	6548					

FORM H: RATIO TECHNIQUE

		1	2	3	4	5	6	7	8	9	10	11	
1	SCHOOL YEAR						1970-71	1971-72	1972-73	1973-74	1974-75		
2	T						1	2	3	4	5		
3	ENROLLMENT (L)						9277	8823	8373	7795	7320		
4	AREA POP. (A)						153,927	153,930	152,262	150,900	149,100		
5	L/A = R (ratio)						.0602	.0573	.0550	.0517	.0491		
6	$\bar{R}$	.0547											
7	$\bar{T}$	3											
8	$T - \bar{T} = t$						–2	–1	0	1	2		
9	t^2						4	1	0	1	4		
10	Σt^2	10											
11	$R \bullet t$						–.1204	–.0573	0	.0517	.0982		
12	$\Sigma R \bullet t$	-.0278											
13	$\Sigma R \bullet t / \Sigma t^2 = B$	-.0028											
14	$B \bullet \bar{T}$	-.0084											
15	SCHOOL YEAR						1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	19
16	T						1	2	3	4	5	6	
17	$\bar{R} - (B \bullet \bar{T})$						.0631	.0631	.0631	.0631	.0631	.0631	
18	$B \bullet T$						–.0028	–.0056	–.0084	–.0112	–.0140	–.0168	–
19	$\hat{R}$						.0603	.0575	.0547	.0519	.0491	.0463	
20	AREA POP. $(\hat{A})$											138,000	14
21	ENROLLMENT $(\hat{L})$						9281	8851	8329	7832	7321	6389	

HISTORICAL DATA | PL

8	9	10	11	12	13	14	15	16	17	18	19	20
1972-73	1973-74	1974-75										
3	4	5										
8373	7795	7320										
152,262	150,900	149,100										
.0550	.0517	.0491										
0	1	2										
0	1	4										
0	.0517	.0982										
1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80					
3	4	5	6	7	8	9	10					
.0631	.0631	.0631	.0631	.0631	.0631	.0631	.0631					
–.0084	–.0112	–.0140	–.0168	–.0196	–.0224	–.0252	–.0280					
.0547	.0519	.0491	.0463	.0435	.0407	.0379	.0351					
			138,000	146,100	144,000	141,300	138,600					
8329	7832	7321	6389	6355	5861	5355	4865					

HISTORICAL DATA | **PLANNING HORIZON**

FORM I: DWELLING UNIT MULTIPLIER TECHNIQUE – HISTORIC YIELD ESTIMATES

SINGLE FAMILY UNITS

		1	2	3	4	5	6	7	8	9	10
1	YEAR						1970-71	1971-72	1972-73	1973-74	1974-75
2	T						1	2	3	4	5
3	ENROLLMENT (E)						12,475	13,241	13,697	13,818	14,153
4	DWELLINGS (D)						5467	6034	6419	6734	6902
5	SAMPLE SIZE (n)						191	191	195	192	200
6	enrollment (e')						170	169	172	170	178
7	$e' / n = x$						.890	.885	.882	.885	.890
8	$x \bullet E = \hat{s}$						11,103	11,718	12,081	12,229	12,596
9	$\hat{s}/D$ = YIELD ($\hat{Y}$)						2.031	1.942	1.882	1.816	1.825

FORM J: DWELLING UNIT MULTIPLIER TECHNIQUE— FORECAST OF YIELDS

		1	2	3	4	5	6	7	8	9	10	11	
1	YEAR						1970-71	1971-72	1972-73	1973-74	1974-75		
2	T						1	2	3	4	5		
3	$\bar{T}$	3											
4	$T - \bar{T} = t$						-2	-1	0	1	2		
5	t^2						4	1	0	1	4		
6	Σt^2	10											
7	YIELD ($\hat{Y}$)						2.031	1.942	1.882	1.816	1.825		
8	$\bar{Y}$	1.899											
9	$\hat{Y} \cdot t$						-4.062	-1.942	0	1.816	3.650		
10	$\Sigma \hat{Y} \cdot t$	-.538											
11	$\Sigma \hat{Y} \cdot t / \Sigma t^2 = B$	-.054											
12	$B \cdot \bar{T}$	-.162											
13	YEAR						1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	19
14	T						1	2	3	4	5	6	
15	$\bar{Y} - (B \cdot \bar{T})$						2.061	2.061	2.061	2.061	2.061	2.061	
16	$B \cdot T$						-.054	-.108	-.162	-.216	-.270	-.324	
17	YIELD ($\hat{Y}$)						2.007	1.953	1.899	1.845	1.791	1.737	

HISTORICAL DATA PL

8	9	10	11	12	13	14	15	16	17	18	19	20
1972-73	1973-74	1974-75										
3	4	5										
0	1	2										
0	1	4										
1.882	1.816	1.825										
0	1.816	3.650										
1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80					
3	4	5	6	7	8	9	10					
2.061	2.061	2.061	2.061	2.061	2.061	2.061	2.061					
-.162	-.216	-.270	-.324	-.378	-.432	-.486	-.540					
1.899	1.845	1.791	1.737	1.683	1.629	1.575	1.521					

HISTORICAL DATA

PLANNING HORIZON

FORM K: DWELLING UNIT MULTIPLIER TECHNIQUE— FORECAST OF DWELLINGS AND ENROLLMENT

DWELLING UNIT TYPE: SINGLE-FAMILY UNITS

		1	2	3	4	5	6	7	8	9	10	11	
1	YEAR						1970-71	1971-72	1972-73	1973-74	1974-75		
2	T						1	2	3	4	5		
3	$\overline{T}$	3											
4	$T - \overline{T} = t$						-2	-1	0	1	2		
5	t^2						4	1	0	1	4		
6	Σt^2	10											
7	DWELLINGS (D)						5467	6034	6419	6734	6902		
8	MAXIMUM D (K)	7200											
9	K / D						1.317	1.193	1.122	1.069	1.043		
10	K/D – 1						.317	.193	.122	.069	.043		
11	ln (K/D -1) = X						–1.15	–1.65	–2.10	–2.67	–3.15		
12	$\overline{X}$	–2.144											
13	X • t						2.30	1.65	0	-2.67	-6.30		
14	ΣX • t	–5.02											
15	ΣX • t/ Σ t^2 = B	–.502											
16	B • $\overline{T}$	-1.506											
17	YEAR						1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	19
18	T						1	2	3	4	5	6	
19	$\overline{X}$ – (B•$\overline{T}$)						–.638	–.638	–.638	–.638	–.638	–.638	
20	B • T						–.502	–1.004	–1.506	–2.008	–2.510	–3.012	
21	$\hat{X}$						–1.140	–1.642	–2.144	–2.646	–3.148	–3.650	
22	K/D – 1						.320	.194	.121	.072	.043	.026	
23	K/D						1.320	1.194	1.121	1.072	1.043	1.026	
24	DWELLINGS ($\hat{D}$)						5455	6030	6423	6716	6903	7018	
25	YIELD ($\hat{Y}$)											1.737	
26	ENROLLMENT ($\hat{E}$)											12,190	1

HISTORICAL DATA

PL

NIT TYPE: SINGLE-FAMILY UNITS

	8	9	10	11	12	13	14	15	16	17	18	19	20
-72	1972-73	1973-74	1974-75										
	3	4	5										
	0	1	2										
	0	1	4										
4	6419	6734	6902										
3	1.122	1.069	1.043										
3	.122	.069	.043										
5	-2.10	-2.67	-3.15										
5	0	-2.67	-6.30										
2	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80					
	3	4	5	6	7	8	9	10					
8	-.638	-.638	-.638	-.638	-.638	-.638	-.638	-.638					
4	-1.506	-2.008	-2.510	-3.012	-3.514	-4.016	-4.518	-5.02					
2	-2.144	-2.646	-3.148	-3.650	-4.152	-4.654	-5.156	-5.658					
4	.121	.072	.043	.026	.016	.010	.006	.004					
4	1.121	1.072	1.043	1.026	1.016	1.010	1.006	1.004					
	6423	6716	6903	7018	7087	7129	7157	7171					
				1.737	1.683	1.629	1.575	1.521					
				12,190	11,927	11,613	11,272	10,907					

HISTORICAL DATA | **PLANNING HORIZON**

FORM L: ENROLLMENT FORECAST BY GRADE

		1	2	3	4	5	6	7	8	9	10
1	YEAR	1975-76	1976-77	1977-78	1978-79	1979-80					
2	ENROLLMENT 1	7182	6766	6489	6175	5853					
3	ENROLLMENT 2	6886	6468	6139	5804	5491					
4	ADJUSTMENT	1.043	1.046	1.057	1.064	1.066					
	GRADE LEVEL :										
5	12	652	592	579	532	508					
6	11	632	614	565	544	528					
7	10	653	596	576	562	561					
8	9	615	590	578	579	483					
9	8	589	573	576	482	435					
10	7	579	577	484	439	424					
11	6	592	493	449	435	446					
12	5	501	453	441	453	391					
13	4	470	454	468	406	405					
14	3	466	477	415	416	401					
15	2	492	425	427	414	427					
16	1	443	442	430	446	416					
17	K	496	479	499	467	429					

FORM M: SUB-GEOGRAPHIC REGION FORECASTS

		1	2	3	4	5	6	7	8	9	10
1	YEAR	1975-76	1976-77	1977-78	1978-79	1979-80					
	REGION										
2	1	3705	3680	3418	3160	3007					
3	2	2682	2788	2536	2584	2557					
4	3	957	401	784	596	482					
5											
6	ENROLLMENT 2	7344	6869	6738	6340	6046					
7	ENROLLMENT 1	7182	6766	6489	6175	5853					
8	ADJUSTMENT	.978	.985	.963	.974	.968					
	REGION										
9											
10											
11											
12											

FORM N: SMALL AREA FORECASTS

	1	2	3	4			5			6		
YEAR	current year			1975-76			1976-77			1977-78		
	a	b	c	a	b	c	a	b	c	a	b	c
AREA												
1	154	220	1.43	284	406	390	315	450	436	418	598	568
2	689	137	2.01	691	1389	1333	703	1413	1371	703	1413	1342
3	477	649	1.36	491	668	641	571	777	754	593	806	766
4	359	528	1.47	509	748	718	582	856	830	598	879	835
5	443	806	1.82	577	1050	1008	668	1216	1180	769	1400	1330
6	154	223	1.45	154	223	214	154	223	216	154	223	212
7	657	644	.98	791	775	744	882	864	838	932	913	867
8	140	216	1.54	151	233	224	164	253	245	172	265	252
9	846	1489	1.76	846	1489	1429	848	1492	1447	851	1498	1423

	10			11			12			13		
YEAR												
	a	b	c	a	b	c	a	b	c	a	b	c
AREA												

	6			7			8			9		
-77	1977-78			1978-79			1979-80					
c	a	b	c	a	b	c	a	b	c	a	b	c
436	418	598	568	425	608	596	440	629	604			
1371	703	1413	1342	713	1433	1404	715	1437	1380			
754	593	806	766	604	821	805	612	832	799			
830	598	879	835	703	1033	1012	710	1044	1002			
1180	769	1400	1330	778	1416	1388	778	1416	1359			
216	154	223	212	155	225	221	155	225	216			
838	932	913	867	962	943	924	1036	1015	974			
245	172	265	252	181	279	273	189	291	279			
1447	851	1498	1423	856	1507	1477	887	1561	1499			

	13			14			15			16		
c	a	b	c	a	b	c	a	b	c	a	b	c

FORM O: SMALL AREA FORECASTS— ADJUSTMENT COMPUTATION

		1	2	3	4	5	6	7	8	9	10
1	YEAR	1975-76	1976-77	1977-78	1978-79	1979-80					
2	ENROLLMENT	8936	9262	10697	9877	10400					
3	TOTAL OF AREAS	9308	9549	11260	10079	10833					
4	ADJUSTMENT	.96	.97	.95	.98	.96					

FORM P: **SMALL AREA FORECASTS**

Area Enrollment Totals
Region: #1

		1	2	3	4	5	6	7	8	9	10
1	YEAR	1975-76	1976-77	1977-78	1978-79	1979-80					
2	AREA										
3	1	435	478	682	685	640					
4	2	1486	1503	1610	1614	1463					
5	3	715	827	919	826	847					
6	4	801	910	1002	1164	1062					
7	5	1124	1294	1596	1596	1440					
8	6	239	236	254	254	229					
9	7	830	919	1040	1063	1032					
10	8	250	270	302	314	296					
11	9	1593	1647	1708	1699	1703					
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											

Chapter 3 FACILITY COMPONENT

Form A Future Facility Needs
B Course Per Student and Periods Per Course

FORM A: FUTURE FACILITY NEEDS

School (i) ____________________ Subject are

YEAR:	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81
1. (N i) Enrollment	880	845	866	793	783	767
2. (Aij) Courses per student	1.66	1.70	1.74	1.78	1.82	1.86
3. Line 1 x Line 2 : Course enrollment	1461	1436	1507	1412	1425	1427
4. (Wij) Periods per course	4.76	4.77	4.77	4.78	4.79	4.80
5. Line 3 x Line 4 : Student-periods	6954	6850	7188	6749	6826	6850
6. (Pij) Periods per day	6	6	6	6	6	6
7. Line 5 / Line 6 : Student-days	1159	1142	1198	1125	1138	1142
8. (Dij) Days per week	5	5	5	5	5	5
9. Line 7 / Line 8 : Enrollment per period	232	228	240	225	228	228
10. (Uij) Utilization rate	.90	.90	.90	.90	.90	.90
11. Line 9 / Line 10 : Effective Enrollment	258	253	267	250	253	253
12. (Tij) Students per teaching station	25	25	25	25	25	25
13. Line 11 / Line 12 : Required Teaching Stations	10.3	10.1	10.7	10.0	10.1	10.1
14. Existing teaching stations	12	12	12	12	12	12
15. Line 13 – Line 14 : Teaching Station Need	–1.7	–1.9	–1.3	–2	–1.9	–1.9
16. (Fij) Square feet per student	30	30	30	30	30	30
17. Line 11 x Line 16 : Required Square Feet	7740	7590	8010	7500	7590	7590
18. Existing square feet	9000	9000	9000	9000	9000	9000
19. Line 17 – Line 18 : Square Footage Need	–1260	–1410	– 990	–1500	–1410	–1410

Subject area (j) Academic

78-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	
793	783	767	652	602	573	497	479	
1.78	1.82	1.86	1.90	1.94	1.98	2.02	2.06	
1412	1425	1427	1239	1168	1135	1004	987	
4.78	4.79	4.80	4.80	4.81	4.82	4.82	4.83	
6749	6826	6850	5947	5618	5471	4839	4767	
6	6	6	6	6	6	6	6	
1125	1138	1142	991	936	912	806	795	
5	5	5	5	5	5	5	5	
225	228	228	198	187	182	161	159	
.90	.90	.90	.90	.90	.90	.90	.90	
250	253	253	220	208	202	179	177	
25	25	25	25	25	25	25	25	
10.0	10.1	10.1	8.8	8.3	8.1	7.2	7.1	
12	12	12	12	12	12	12	12	
-2	-1.9	-1.9	-3.2	-3.7	-3.9	-4.8	-4.9	
30	30	30	30	30	30	30	30	
7500	7590	7590	6600	6240	6060	5370	5310	
000	9000	9000	9000	9000	9000	9000	9000	
1500	-1410	-1410	-2400	-2760	-2940	-3630	-3690	

FORM B: **COURSES PER STUDENT AND PERIODS PER COURSE**

School (i) ____________________ Subject Ar

COURSES PER STUDENT (Aij), PERIODS PER COURSE (Wij) by SUBJECT AREA	Year 1971–72			Year 1972–73			Y
COURSE NAME	Course Enrollment a	Course Periods Per Week b	Students Per Week c	Course Enrollment a	Course Periods Per Week b	Students Per Week c	Course a
Math I	180	5	900	191	5	955	18
Math II	185	5	925	180	5	900	19
Algebra	87	3	261	84	3	252	8
English 7	115	5	575	121	5	605	12
English 8	109	5	545	111	5	555	12
Literature	92	3	276	87	3	261	8
Geography	201	5	1005	206	5	1030	21
French I	105	5	525	109	5	545	11
French II	103	5	515	103	5	515	10
Spanish I	156	5	780	162	5	810	17
1. Column a. Total	1333			1354			13
2. Number of Students Enrolled	884			881			88
3. Line 1 / Line 2 : (A_{ij}) Courses per Student	1.51			1.54			1.5
4. Column c. Total			6307			6428	
5. Line 4 / Line 1 : (W_{ij}) Periods per Course			4.73			4.75	

Subject Area (j) Academic

		Year 1973–74			Year 1974–75			Year 1975–76		
Per Week	Students Per Week c	Course Enrollment a	Course Periods Per Week b	Students Per Week c	Course Enrollment a	Course Periods Per Week b	Students Per Week c	Course Enrollment a	Course Periods Per Week b	Students Per Week c
	955	184	5	920	206	5	1030	192	5	960
	900	191	5	955	202	5	1010	206	5	1030
	252	81	3	240	84	3	252	84	3	252
	605	129	5	645	138	5	690	135	5	675
	555	120	5	600	125	5	625	123	5	615
	261	88	3	264	93	3	279	94	3	282
	1030	210	5	1050	222	5	1110	214	5	1070
	545	111	5	555	118	5	590	120	5	600
	515	105	5	525	104	5	520	110	5	550
	810	171	5	855	183	5	915	181	5	905
		1390			1475			1459		
		889			906			880		
		1.56			1.63			1.66		
	6428			6609			7021			6939
	4.75			4.75			4.76			4.76

Chapter 4 FISCAL COMPONENT

Form	A	Summary of Expenses
	B	Summary of Revenues
	C	Summary of Bonding Capacity
	D	Summary of Fiscal Projections
	E	Building Cost
	F	Total Employees
	F.1	Total Employees/Alternative
	G	Salaries and Benefits
	H	Supplies and Services
	I.1	Linear Growth or Decline
	I.2	Nonlinear Growth
	I.3	Nonlinear Decline
	J	Real Property Tax Revenue
	K	Sales and Other Local Taxes
	L	Activities Fees
	M	Earnings on Investments
	N	State Aid Based on Enrollment
	O	State Aid Based on Assessed Valuation
	P	Federal Revenue

FORM A: SUMMARY OF EXPENSES

(* Indicates figures in thousands of dollars)

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9	10	
100	YEAR	’65	’66	’67	’68	’69	’70	’71	’72	’73	’74	
101	Building Expenditures (Form E, Line 6)											18
102	Land Expenditures											32
103	Total Capital Expenditures * (Line 101+Line 102)											50
104	Salaries and Benefits * (Form G, Line 3)											2
105	Supplies and Services * (Form H, Line 3)											
106	Other Operating Expenses											
107	Total Operating Expenses * (Lines 104, 105, 106)											2
108	Total Expenses * (Line 103+Line 107)											27

8	9	10	11	12	13	14	15	16	17	18	19	20
'72	'73	'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
			188,114	807,923								
			320,000	170,000	585,000	250,000	250,000					
			508.1	977.9	585.0	250.0	250.0					
			20,393	21,840	23,865	24,816	26,357	27,859	29,456	30,884	32,273	33,875
			6,237	6,901	7,713	8,538	9,425	10,363	11,396	12,514	13,722	15,037
			–	–	–	–	–	–	–	–	–	–
			26,630	28,801	31,578	33,354	35,782	38,222	40,852	43,398	45,995	48,912
			27,138.1	29,778.9	32,163	33,604	39,032	38,222	40,852	43,398	45,995	48,912

FORM B: SUMMARY OF REVENUES

(*Indicates figures in thousands of dollars)

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9	10
200	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73	'74
201	Assessed Valuation * (Form J, Line 3)	2,136	3,157	3,784	5,772	6,468	7,191	11,641	12,394	15,578	17,143
202	Tax Rate (Form J, Line 22)	$5.36	$5.36	$5.36	$5.36	$5.36	$5.36	$5.36	$5.36	$5.36	$5.36
203	Property Taxes * (Line 201xLine 202)	108.8	160.7	192.7	293.9	329.4	366.1	592.8	631.1	793.3	873.0
204	Other Taxes * (Form K, Line 17)	4	6	9	10	14	16	19	28	30	38
205	Total Tax Revenue * (Line 203+Line 204)	112.8	166.7	201.7	303.9	343.4	382.1	611.8	659.1	823.3	911.0
206	Non-Tax Revenue * (Forms L, M, etc.)	195.5	290.0	343.5	508.1	600.5	660.7	958.4	1,023.9	1,193.8	1,335.1
209	Intermediate Source Revenue *	161.5	235.9	287.8	412.1	562.2	629.2	753.5	874.5	1,097.6	1,120.7
210	Total Local Revenue * (Lines 205+206+209)	469.8	692.6	833.0	1,224.1	1,506.1	1,672.0	2,323.7	2,557.5	3,114.7	3,366.8
215	Unrestricted Grants-in-Aid *	1,000.4	1,749.7	2,579.2	3,568.6	4,411.3	4,925.2	5,310.1	5,661.7	6,040.1	6,259.4
216	Restricted Grants-in-Aid *	95.2	146.0	127.8	667.9	842.0	858.0	1,052.1	1,297.1	971.0	854.2
217	Revenue in Lieu of Taxes	N/A									
218	Revenue for/on Behalf of District	N/A									
220	Total State Revenue * (Lines 215+216+217+218)	1,095.6	1,895.7	2,707.0	4,236.5	5,253.3	5,783.2	6,362.2	6,958.8	7,011.1	7,113.6
225	Total Federal Revenue *	74.3	133.8	202.0	250.5	217.6	359.7	587.7	675.7	623.2	699.8
230	Total Income * (Lines 210+220+225)	1,639.7	2,722.1	3,742.0	5,711.1	6,977.0	7,814.9	9,273.6	10,192.0	10,749.0	11,180.2

	8	9	10	11	12	13	14	15	16	17	18	19	20
1	'72	'73	'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
641	12,394	15,578	17,143	18,439	20,974	23,641	26,444	29,387	32,475	35,730	39,158	42,764	46,553
36	$5.36	$5.36	$5.36	$5.36	$5.36	$5.36	$5.36	$5.36	$5.36	$5.36	$5.36	$5.36	$5.36
	631.1	793.3	873.0	938.6	1,067.8	1,203.6	1,346.2	1,496.3	1,654.0	1,819.3	1,909.5	2,177.4	2,370.3
	28	30	38	40	40	43	45	47	47	47	49	49	51
	659.1	823.3	911.0	978.6	1,107.8	1,246.6	1,391.2	1,545.3	1,701.0	1,866.3	1,958.5	2,226.4	2,421.3
	1,023.9	1,193.8	1,335.1	1,356.6	1,499.7	1,645.2	1,797.0	1,955.3	2,119.1	2,291.0	2,386.8	2,659.8	2,857.3
	874.5	1,097.6	1,120.7	1,233.4	1,346.1	1,458.8	1,571.5	1,684.2	1,796.9	1,909.6	2,022.3	2,135.0	2,247.7
.7	2,557.5	3,114.7	3,366.8	3,568.6	3,953.6	4,351.6	4,758.7	5,184.8	5,617.0	6,066.9	6,367.6	7,021.2	7,526.3
.1	5,661.7	6,040.1	6,259.4	6,479.9	6,690.4	6,840.7	6,981.1	7,101.3	7,181.3	7,271.7	7,341.9	7,402.0	7,452.1
.1	1,297.1	971.0	854.2	866.7	906.1	925.2	943.4	959.0	969.1	980.5	989.3	996.9	1,003.3
.2	6,958.8	7,011.1	7,113.6	7,346.6	7,596.5	7,765.9	7,924.5	8,060.3	8,150.4	8,252.2	8,331.2	8,398.9	8,455.4
	675.7	623.2	699.8	748.0	796.0	850.0	885.0	935.0	977.0	1,021.0	1,060.0	1,096.0	1,124.0
6	10,192.0	10,749.0	11,180.2	11,663.2	12,346.1	12,967.5	13,568.2	14,180.1	14,744.4	15,340.1	15,758.8	16,516.1	17,105.7

FORM C: SUMMARY OF BONDING CAPACITY

(*Indicates figures in thousands of dollars)

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9	10
300	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73	'74
301	Assessed Valuation * (Form B, Line 201)										
302	Other Variables *										
303	Total Capacity Base * (Line 301+Line 302)										
304	Bonding Capacity Percentage										
305	Gross Bonding Capacity * (Line 304xLine 303)										
306	Current Outstanding Indebtedness*										
307	Retirement Schedule--Existing Debt *										
308	Net Bonding Capacity * (Line 305-Line 306)										
309	Proposed Bonded Indebtedness *										
310	Retirement Schedule—Proposed Debt *										
311	Net Bonding Capacity * (Line 308-Line 309)										

8	9	10	11	12	13	14	15	16	17	18	19	20
'72	'73	'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
			18,439	20,974	23,641	26,444	29,387	32,475	35,730	39,158	42,764	46,553
			8,666	9,858	11,111	12,429	13,812	15,263	16,793	18,404	20,099	21,880
			27,105	30,832	34,752	38,873	43,199	47,738	52,523	57,562	62,863	68,433
			10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
			2,711	3,083	3,475	3,887	4,320	4,774	5,252	5,756	6,286	6,843
			177.6	170.5	163.2	155.5	147.4	139.1	130.4	121.4	111.9	102.0
			6.7	7.1	7.3	7.7	8.1	8.3	8.7	9.0	9.5	9.9
			2,533.4	2,912.5	3,311.8	3,731.5	4,172.6	4,634.9	5,121.6	5,634.6	6,174.1	6,741.0
			1,000.0	900.0	800.0	2,700.0	2,300.0	1,900.0	1,500.0	1,600.0	1,150.0	700.0
			–	100.0	100.0	100.0	400.0	400.0	400.0	400.0	450.0	450.0
			1,533.4	2,012.5	2,511.8	1,031.5	1,872.6	2,734.9	3,621.6	4,034.6	5,024.1	6,041.0

FORM D: SUMMARY OF FISCAL PROJECTIONS

(*Indicates figures in thousands of dollars)

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9	10	1
400	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73	'74	'
405	Total Revenue * (Form B, Line 230)											11,
410	Total Operating Expenditures * (Form A, Line 107)											26,
415	Total Revenue from Bonded Indebtedness *											1,
421	Payments on Principal—Existing * (Form C, Line 307)											
422	Interest Payments—Existing *											
423	Payments on Principal—Proposed * (Form C, Line 310)											
424	Interest Payments—Proposed *											
425	Total Bond Payments * (Sum Lines 421-424)											1
430	Total Capital Expenditures * (Form A, Line 103)											50
440	Total Income * (Line 405+Line 415)											12,
450	Total Expenses * (Lines 410, 425, 430)											27,
460	Cash Flow * (Line 440-Line 450)											-14,
470	Balance * (Line $470_{t-1}-460_t$)										30,148.7	15,

7	8	9	10	11	12	13	14	15	16	17	18	19	20
71	'72	'73	'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
				11,662.2	12,348.1	12,967.5	13,570.2	14,179.1	14,747.4	15,345.1	15,763.8	16,523.1	17,112.7
				26,630.0	28,801.0	31,578.0	33,354.0	35,782.0	38,222.0	40,852.0	43,398.0	45,995.0	48,912.0
				1,000.0	–	–	–	2,000.0	–	–	500.0	–	–
				6.7	7.1	7.3	7.7	8.1	8.3	8.7	9.0	9.5	9.9
				3.5	3.4	3.1	2.8	2.6	2.4	2.3	2.1	2.0	1.8
				0	100.0	100.0	100.0	400.0	400.0	400.0	400.0	450.0	450.0
				0	140.0	130.0	120.0	600.0	550.0	500.0	450.0	450.0	400.0
				10.2	250.5	240.4	230.5	1,010.7	960.7	911.0	861.1	911.5	861.7
				508.1	977.9	585.0	250.0	250.0	–	–	–	–	–
				12,662.2	12,348.1	12,967.5	13,570.2	16,179.1	14,747.4	15,345.1	16,263.8	16,523.1	17,112.7
				27,148.3	30,029.4	32,403.4	33,834.5	37,042.7	39,182.7	41,763.0	44,259.1	46,906.5	49,773.7
				-14,486.1	-17,681.3	-19,435.9	-20,264.3	-20,863.6	-24,435.3	-26,417.9	-27,995.3	-30,383.4	-32,661.0
			30,148.7	15,662.6	- 2,018.7	-21,454.6	-41,718.9	-62,582.5	-87,017.8	-113,435.7	-141,431.0	-171,814.4	-204,475.4

FORM E: BUILDING COST

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9	10	
1	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73	'74	
2	BCI	281	288	293	304	325	344	375	402	436	467	
2a												
2b												
3	% △ BCI		2.5	1.7	3.8	6.9	5.8	9.0	7.2	8.5	7.1	
3a												
3b												
4	Current Building Cost (CBC)											17
5	Deflated Bldg. Cost (Line 4 ÷ Line 2, Col. 10)											37
6	Future Bldg. Cost (Line 2xLine 5)											18
6a												18
6b												18

8	9	10	11	12	13	14	15	16	17	18	19	20
'72	'73	'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
402	436	467	502	539	579	621	667	717	770	825	888	954
			504	545	588	635	686	741	800	864	934	1008
			500	530	557	579	602	627	652	678	705	733
7.2	8.5	7.1	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
			8	8	8	8	8	8	8	8	8	8
			7	6	5	4	4	4	4	4	4	4
			175,000	700,000								
			374.7	1,498.9								
			188,114	807,923								
			188,863	816,911								
			187,365	794,427								

FORM F: TOTAL EMPLOYEES

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9
1	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73
2	Total Employees	—	798	970	1205	1360	1463	1664	1879	2010
3	Teachers (Facility Component)		438	538	668	778	854	899	967	1020
4	Emp./Teacher Ratio (Line 2 ÷ Line 3)		1.82	1.80	1.80	1.74	1.71	1.85	1.94	1.97

10	11	12	13	14	15	16	17	18	19	20
'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
2128	2194	2259	2304	2346	2382	2407	2433	2456	2473	2489
1120	1155	1189	1213	1235	1254	1267	1281	1293	1302	1310
1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90

FORM F.1: TOTAL EMPLOYEES/ALTERNATIVE

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9
1	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73
2	t				1	2	3	4	5	6
3	$\bar{t}$ (average Line 2)	4								
4	$(t-\bar{t})$ (Line 2-Line 3)				-3	-2	-1	0	1	2
5	$(t-\bar{t})^2$ $(\text{Line } 4)^2$				9	4	1	0	1	4
6	$\sum(t-\bar{t})^2$ (Sum Line 5)	26								
7	Employees ÷ Teachers				1.8	1.74	1.71	1.85	1.94	1.97
8	Average E/T = α (Average Line 7)	1.84								
9	$(t-\bar{t}) \bullet (E/T)$ (Line 4xLine 7)				-5.4	-3.5	-1.7	.0	+1.9	+3.9
10	$\sum(t-\bar{t}) \bullet (E/T)$ (Sum Line 9)	.9								
11	$\hat{B}$ (Line 10 ÷ Line 6)	.0346								
12	$\bar{t} \times \hat{B}$ (Line 3xLine 11)	.1385								
13	YEAR (Line 1)	'65	'66	'67	'68	'69	'70	'71	'72	'73
14	YEAR t (Line 2)				1	2	3	4	5	6
15	$\alpha - \bar{t}\,\hat{B}$ (Line 8-Line 12)				1.7	1.7	1.7	1.7	1.7	1.7
16	$\hat{B} \bullet t$ (Line 11xLine 14)				.035	.07	.105	.14	.175	.21
17	$\alpha - \bar{t} \bullet \hat{B} + \hat{B} \bullet t$ (Line 15+Line 16)				1.74	1.77	1.81	1.84	1.88	1.91

10	11	12	13	14	15	16	17	18	19	20
'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
7										
3										
9										
1.90										
+5.7										
'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
7	8	9	10	11	12	13	14	15	16	17
1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
.245	.28	.315	.35	.385	.42	.455	.49	.525	.56	.60
1.95	1.98	2.02	2.05	2.09	2.12	2.16	2.19	2.23	2.26	2.30

FORM G: SALARIES AND BENEFITS

(* indicates figures in thousands)

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9
1	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73
2	Total (t) Employees		798	970	1,205	1,360	1,463	1,664	1,879	2,010
3	Total Salaries and Benefits *	3,372.1	4,154.5	5,198.2	7,990.1	11,476.4	13,173.5	15,512.3	16,941.0	18,654.8
4	Avg. Sal. & Ben.=(Y) (Line 3 ÷ Line 2)		5,205	6,100	6,630	8,438	9,004	9,322	9,015	9,281
5	Per Capita Income Proj. = (X)	3,320	3,450	3,575	3,675	3,765	3,776	3,828	3,980	4,125
6	$\ln Y$ Natural Log Line 4		8.55642	8.71605	8.79936	9.04074	9.10498	9.13992	9.10610	9.13652
7	$\sum \ln Y \div n$ (Avg. Line 6)	8.9738								
8	$(\overline{X})$ Avg. Line 5	3824								
9	$(X - \overline{X})$ (Line 5-Line 8)		-374	-249	-149	-59	-48	4	156	301
10	$(X - \overline{X})^2$ $(\text{Line } 9)^2$		139,876	62,001	22,201	3,481	2,304	16	24,336	90,601
11	Sum $(X - \overline{X})^2$ * (Sum Line 10)	526.3								
12	$(X - \overline{X})\ (\ln Y)$ (Line 9xLine 6)		-3,200.1	-2,170.3	-1,311.1	-533.4	-437.0	36.5	1,420.5	2,749.8
13	Sum $(X - \overline{X})\ (\ln Y)$ (Sum Line 12)	189.3								
14	B (Line 13 ÷ Line 11)	.0003								
15	$B \bullet \overline{X}$ (Line 14xLine 8)	1.1472								
16	$\alpha = \overline{\ln Y} - B\overline{X}$ (Line 7-Line 15)	1.8266								
17	$\ln Y = \alpha + BX$ [Line 16 + [Line 14 x Line 15)]									
18	Antilog ln Y (Antilog Line 17)									

10	11	12	13	14	15	16	17	18	19	20
'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
2,128	2,194	2,259	2,304	2,346	2,382	2,407	2,433	2,456	2,473	2,489
0,347.9	20,393	21,840	23,865	24,816	26,357	27,859	29,456	30,884	32,273	33,875
9,562										
4,250	4,380	4,500	4,700	4,800	4,950	5,100	5,250	5,375	5,500	5,640
9.16535										
426										
181,476										
3,904.4										
	9.1406	9.1766	9.2366	9.2666	9.3116	9.3566	9.4016	9.4395	9.4766	9.5186
	9295	9668	10358	10578	11065	1157[illegible]	12107	12575	13050	13610

FORM H: SUPPLIES AND SERVICES

(*Indicates figures in thousands of dollars)

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9	
1	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73	
2	Enrollment	8,482	10,351	12,420	14,888	16,990	18,272	19,232	20,109	21,053	2
3	Cost - Supplies and Services *	1,018.4	1,465.8	1,645	2,333	2,754	3,189	4,022	4,386	5,087	
4	Cost/Student (Line 3 ÷ Line 2)	120.1	141.6	132.4	156.7	162.0	174.5	209.1	218.1	241.6	
5	(t) - (t-1) △ Cost/Student		21.5	-9.2	24.3	5.3	12.5	24.6	9.0	23.5	
6	% Cost/Student (Line 5 ÷ Line 4)		.152	.069	.155	.038	.072	.118	.041	.097	
7	Average % Cost/Stu. (∑ Line 6 ÷ n)										
8	Projected % Change (Line 7 + 1)										
9	Future Year I.D. (Year = t)										
10	Exponent (Line 8)^t										
11	Projected Cost/Stu. (Line 10xLine 4; Col. 10)										

10	11	12	13	14	15	16	17	18	19	20
74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
,600	22,150	22,675	23,050	23,400	23,700	23,900	24,125	24,300	24,450	24,575
[illegible]81	6,237	6,961	7,713	8,538	9,425	10,363	11,396	12,514	13,722	15,037
58.4										
16.8										
.065										
.090										
	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09
	1	2	3	4	5	6	7	8	9	10
	1.09	1.188	1.295	1.412	1.539	1.678	1.828	1.993	2.172	2.368
	281.7	307.0	334.6	364.9	397.7	433.6	472.3	515.0	561.2	611.9

FORM I.1: LINEAR GROWTH OR DECLINE

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9
1	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73
2	t	1	2	3	4	5	6	7	8	9
3	$\bar{t}$ (Avg. Line 2)	5.5								
4	$t - \bar{t}$ (Line 2-Line 3)	–4.5	–3.5	–2.5	–1.5	–.5	.5	1.5	2.5	3.5
5	$(t - \bar{t})^2$ (Line 4^2)	20.25	12.25	6.25	2.25	.25	.25	2.25	6.25	12.25
6	$\sum(t - \bar{t})^2$ (Sum Line 5)	82.5								
7	Structures (ST)	600	800	900	1,200	1,300	1,400	2,000	2,100	2,600
8	Avg. ST = α (Avg. Line 7)	1,570								
9	$(t-\bar{t}) \times (ST)$ (Line 4 x Line 7)	–2,700	–2,800	–2,250	–1,800	–650	700	3,000	5,250	9,100
10	$\sum[(t-\bar{t}) \times (ST)]$ (Sum Line 9)	20,450								
11	$\hat{B}$ (Line 10 ÷ Line 6)	248								
12	$\bar{t} \times \hat{B}$ (Line 3xLine 11)	1,364								
13	YEAR (Line 1)	'65	'66	'67	'68	'69	'70	'71	'72	'73
14	t (Line 2)	1	2	3	4	5	6	7	8	9
15	$\alpha - (\bar{t} \times \hat{B})$ (Line 8-Line 12)	206								
16	$t \times \hat{B}$ (Line 14xLine 11)	248	496	744	992	1,240	1,488	1,736	1,984	2,232
17	$\hat{ST}$ (Line 15+Line 16)	454	702	950	1,198	1,446	1,694	1,942	2,190	2,438
		201								

0	11	12	13	14	15	16	17	18	19	20
4	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
0										
4.5										
20.25										
2,800										
2,690										
74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
10	11	12	13	14	15	16	17	18	19	20
2,480	2,728	2,976	3,224	3,472	3,720	3,968	4,216	4,464	4,712	4,960
2,686	2,934	3,182	3,430	3,678	3.926	4,174	4,422	4,670	4,918	5,166

FORM I.2: NONLINEAR GROWTH

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9
1	YEAR						'70	'71	'72	'73
2	t						1	2	3	4
3	$\bar{t}$ (Avg. Line 2)	3								
4	$(t-\bar{t})=x$ (Line 2-Line 3)						–2	–1	0	1
5	x^2 (Line 4)^2						4	1	0	1
6	$\sum x^2$ (Sum Line 5)	10								
7	Structures (ST)						1,500	1,850	1,975	2,100
8	Upper Limit (K)	2,400								
9	K/ST (Line 8 ÷ Line 7)						1.6	1.3	1.22	1.14
10	K/ST - 1 (Line 9 –1)						.6	.3	.22	.14
11	ln (K/ST - 1) = Y (ln Line 10)						–.051	–1.2	–1.51	–1.97
12	$\bar{Y} = \alpha$ (Avg. Line 11)	–1.43								
13	Y x (Line 11xLine 4)						+.102	+1.20	0	–1.97
14	$\sum Y x$ (Sum Line 13)	–3.078								
15	$\sum Y x \div \sum x^2 = \hat{B}$ (Line 14 ÷ Line 6)	–.3078								
16	$\hat{B} \times \bar{t}$ (Line 15xLine 3)	–.9234								
17	YEAR						'70	'71	'72	'73
18	t						1	2	3	4
19	$\alpha - \hat{B}\bar{t}$ (Line 12-Line 16)						–.507	–.507	–.507	–.507
20	B t (Line 18xLine 15)						–.3078	–.6156	–.9234	-1.2312
21	Line 20+Line 19						–.8148	-1.1226	-1.4304	–1.782
22	Antilog Line 21 (K/ST –1)						.4427	.3254	.2392	.1683
23	Line 22 + 1 K/ST						1.4427	1.3254	1.2392	1.1683
24	$\hat{ST}$ (Line 8 ÷ Line 23)						1663.5	1810.7	1936.7	2054.3

11	12	13	14	15	16	17	18	19	20
'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
6	7	8	9	10	11	12	13	14	15
-.507	-.507	-.507	-.507	-.507	-.507	-.507	-.507	-.507	-.507
-1.8468	-2.1546	-2.4624	-2.7702	-3.078	-3.3858	-3.6936	-4.0014	-4.3092	-4.617
-2.3538	-2.6616	-2.9694	-3.2772	-3.585	-3.8928	-4.2006	-4.5084	-4.8162	-5.1240
.0950	.0698	.0513	.0377	.0277	.0204	.01498	.01102	.00809	.00595
1.0950	1.0698	1.0513	1.0377	1.0277	1.0204	1.01498	1.01102	1.00809	1.00595
2191.7	2243.4	2282.9	2312.8	2335.3	2352.0	2364.6	2373.8	2380.8	2385.8

FORM I.3: NONLINEAR DECLINE

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9
1	YEAR				'68	'69	'70	'71	'72	'73
2	t	–			1	2	3	4	5	6
3	$\bar{t}$ (Avg. Line 2)	4								
4	$t - \bar{t} = x$ (Line 2-Line 3)				–3	–2	–1	0	1	2
5	x^2 (Line 4)^2	–			9	4	1	0	1	4
6	$\sum x^2$ (Sum Line 5)	28								
7	Structures (ST)				6,000	5,500	5,200	5,100	4,900	4,700
8	Lower Limit (M)	3,000								
9	$ST - M = E'$ (Line 7-Line 5)	–			3,000	2,500	2,200	2,100	1,900	1,700
10	Maximum ST (K)	6,500								
11	$K - M = K'$ (Line 10-Line 8)	3,500								
12	K' / E' (Line 11 ÷ Line 9)				1.1667	1.4	1.591	1.6667	1.8421	2.0588
13	$K'/E'-1$ (Line 12–1)				.1667	.4	.591	.6667	.8421	1.0588
14	$\log (K'/E'-1) = Y$ (log Line 13)				–1.7921	–.9163	–.5261	–.4055	–.1719	.0572
15	$\bar{Y}$ (Avg. Line 14)	–.4953								
16	$\bar{Y}x$ (Line 14 x Line 4)	8.8841			5.376	1.8326	.5261	0	.1719	.1144
17	$\sum \bar{Y}x$ (Sum Line 16)	8.8841								
18	$\sum \bar{Y}x \div \sum x^2 = B$ (Line 17 ÷ Line 6)	.3173								
19	$B\bar{t}$ (Line 18 x Line 3)	1.2692								
20	YEAR				'68	'69	'70	'71	'72	'73
21	t (Line 2)				1	2	3	4	5	6
22	$\bar{Y} - B\bar{t} = \alpha$ (Line 15 - Line 19)				–1.765	–1.765	–1.765	–1.765	–1.765	–1.765
23	Bt (Line 21 x Line 18)				.3173	.6346	.9519	1.2692	1.5865	1.9038
24	$\hat{Y}$ (Line 23+Line 22)				–1.4477	–1.304	–.8131	–.4958	–.1785	.1388
25	Antilog of $\hat{Y}$ (Antilog Line 24)				.2351	.3230	.4435	.6091	.8365	1.1489
26	Antilog of $\hat{Y}$ + 1 (Line 25 + 1)				1.2351	1.3230	1.4435	1.6091	1.8365	2.1489
27	$K' \div$ Antilog of $\hat{Y}+1$ (Line 11 ÷ Line 26)				2833.7	2645.5	2425	2175	1906	1629
28	$(K'/\text{Antilog } \hat{Y}+1)+M$ (Line 27+Line 8)	205			5834	5646	5425	5175	4906	4629

10	11	12	13	14	15	16	17	18	19	20
’74	’75	’76	’77	’78	’79	’80	’81	’82	’83	’84
7										
3										
9										
4,500										
1,500										
2.3333										
1.3333										
.2877										
.5631										
’74	’75	’76	’77	’78	’79	’80	’81	’82	’83	’84
7	8	9	10	11	12	13	14	15	16	17
-1.765	-1.765	-1.765	-1.765	-1.765	-1.765	-1.765	-1.765	-1.765	-1.765	-1.765
2.2211	2.5384	2.8557	3.173	3.4903	3.8076	4.1249	4.4422	4.7595	5.0768	5.3941
.4561	.7734	1.0907	1.408	1.7253	2.0426	2.3599	2.6772	2.9945	3.3118	3.6291
1.5779	2.1671	2.9764	4.0878	5.6142	7.7106	10.5899	14.5443	19.9754	27.4345	37.6789
2.5779	3.1671	3.9764	5.0878	6.6142	8.7106	11.5899	15.5443	20.9754	28.4345	38.6789
1358	1105	880.19	687.9	529.2	401.8	302	225	167	123	90.488
4358	4105	3880	3688	3529	3402	3302	3225	3167	3123	3091

FORM J: REAL PROPERTY TAX REVENUE

(*Indicates figures in thousands of dollars)

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9
1	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73
2	Structures (ST)	600	800	900	1,200	1,300	1,400	2,000	2,100	2,600
3	Assessed Valuation* (AV)	2,136	3,157	3,784	5,772	6,468	7,191	11,641	12,394	15,578
4	Change - Structures [(Line 2(t)- Line 2(t-1)]		200	100	300	100	100	600	100	500
5	AV Per Demolished Unit	2,200	2,300	2,300	2,500	2,600	2,800	2,800	2,800	2,900
6	Demolished Units	–	–40	–20	–35	–20	–15	–25	–40	–25
7	AV Loss * [Line 5xLine 4 (6)]		–92	–46	–87.5	–52	–33.6	–70	–112	–72.5
8	New Units		240	120	335	120	115	625	140	550
9	AV – All New Units *		1,113	694	2,075.5	748	756.6	4,520	865	3,329
10	AV Per New Unit [Line 9÷Line 4 (8)]		4,640	5,780	6,200	6,230	6,580	7,230	6,180	6,340
11	Change AV-New Units [(Line 10) t-(t-1)]			1,140	420	30	350	650	-1,050	160
12	Rate of Change (r) [(Line 11(t) ÷ Line 10(t-1)]			.25	.07	.004	.06	.10	–.14	.03
13	Projection r + 1									
14	Future Years (t)									
15	$(r + 1)^t$									
16	Project AV Per New Unit									
17	AV Gain [(Line 16xLine 4(8)]									
18	Projected Net AV* (Line 17-Line 7)									
19	AV for Sample of Existing Units	510	521	541	554	567	583	600	605	637
20	Historic Growth Rate [(Line 19(t)÷19(t-1)]		1.02	1.04	1.02	1.02	1.03	1.03	1.01	1.05
21	Growth Rate Minus One (Line 17-one)		.02	.04	.02	.02	.03	.03	.01	.05
22	Tax Rate Per Hundred AV	4.81	4.81	5.05	5.05	5.36	5.36	5.36	5.36	5.36
23	Taxes Levied * (Line 22xLine 3)	102.7	151.8	191.1	291.5	346.7	385.4	624.0	664.3	835.0
24	Collection Rate	.90	.91	.91	.92	.92	.92	.92	.95	.95
25	Taxes Collected * (Line 24xLine 23)	92.4	138.1	173.9	268.2	319.0	354.6	574.1	631.1	793.3

10	11	12	13	14	15	16	17	18	19	20
'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
2,800	2,897	3,136	3,375	3,614	3,853	4,092	4,331	4,570	4,809	5,048
17,143	18,561	21,195	24,006	27,023	30,286	33,784	37,563	41,631	46,114	51,031
200	97	239	239	239	239	239	239	239	239	239
2,900	3,000	3,000	3,000	3,300	3,300	3,300	3,300	3,300	3,300	3,300
–55	–50	–50	–50	–50	–50	–50	–50	–50	–50	–50
-159.5	–150	–150	–150	–165	–165	-165	–165	–165	–165	–165
255	147	289	289	289	289	289	289	289	289	289
1,724.5										
6,760										
420										
.07										
	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
	1	2	3	4	5	6	7	8	9	10
	1.06	1.14	1.19	1.26	1.34	1.41	1.50	1.59	1.74	1.89
	7,165	7,706	8,044	8,518	9,058	9,532	10,140	10,748	11,762	12,797
	1,053.3	2,227.0	2,324.7	2,461.7	2,617.7	2,754.7	2,930.5	3,106.2	3,399.2	3,698.3
	903.3	2,077.0	2,174.7	2,296.7	2,452.7	2,589.7	2,765.5	2,941.2	3,234.2	3,533.3
643										
1.01										
.01	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
5.36	5.36	5.36	5.36	5.36	5.36	5.36	5.36	5.36	5.36	5.36
918.9	994.9	1,136.1	1,286.7	1,448.4	1,623.3	1,810.8	2,013.4	2,231.4	2,471.7	2,735.3
.95	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95
873.0	945.2	1,079.3	1,222.4	1,375.0	1,542.1	1,720.3	1,912.7	2,119.8	2,348.1	2,598.5

FORM K: SALES AND OTHER LOCAL TAXES

(* Indicates figures in thousands)

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9
1	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73
2	Commercial Units (CU)	10	10	10	11	11	12	12	14	20
3	$\bar{CU}$ (Avg. Line 2)	13.5								
4	$CU - \bar{CU}$ (Line 2-Line 3)	–3.5	–3.5	–3.5	–2.5	–2.5	–1.5	–1.5	.5	6.5
5	$(CU - \bar{CU})^2$ $(\text{Line } 4)^2$	12.25	12.25	12.25	6.25	6.25	2.25	2.25	.25	42.25
6	$\Sigma(CU - \bar{CU})^2$ (Sum Line 5)	228.5								
7	Sales Taxes * (ST)	4	6	9	10	14	16	19	28	30
8	Avg. ST = α * (Avg. Line 7)	17.4								
9	$(CU - \bar{CU})\ (ST)$ * (Line 4xLine 7)	-14	-21	-31.5	–25	–35	–24	-28.5	14	195
10	$\Sigma[(CU - \bar{CU})\ (ST)]$ * (Sum Line 9)	467								
11	$\hat{B}$ (Line 10 ÷ Line 6)	2,044								
12	$\bar{CU}\ \hat{B}$ (Line 3xLine 11)	27,594								
13	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73
14	CU (Line 2)	10	10	10	11	11	12	12	14	20
15	$\alpha - \bar{CU}\ \hat{B}$ (Line 8-Line 12)	-10,194								
16	$CU \times \hat{B}$ (Line 14xLine 11)	20,440	20,440	20,440	22,484	22,484	24,528	24,528	28,616	40,880
17	$(\alpha - CU\ \hat{B}) + (CU \times \hat{B})$ (Line 15+Line 16)	10,246	10,246	10,246	12,290	12,290	14,334	14,334	18,422	30,686

10	11	12	13	14	15	16	17	18	19	20
'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
25	25	25	26	27	28	28	28	29	29	30
11.5										
132.25										
38										
437										
'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
25	25	25	26	27	28	28	28	29	29	30
51,100	51,100	51,100	53,144	55,188	57,232	57,232	57,232	59,276	59,276	61,320
40,096	40,096	40,096	42,950	44,994	47,038	47,038	47,038	49,082	49,082	51,126

FORM L: ACTIVITIES FEES

(* Indicates figures in thousands)

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9
1	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73
2	Enrollment (E)	8,482	10,351	12,420	14,888	16,990	18,272	19,232	20,109	21,053
3	$\bar{E}$ (Avg. Line 2)	16,340								
4	$E - \bar{E}$ (Line 2-Line 3)	–7,858	–5,989	–3,920	–1,452	650	1,932	2,892	3,769	4,713
5	$(E - \bar{E})^2$ * (Line 4)^2	62,400	36,000	15,200	2,108	423	3,732	8,363	14,400	22,100
6	$\sum (E - \bar{E})^2$ (Sum Line 5)	234,800,000								
7	Activities Fees (AF)	82,701	123,303	141,768	204,189	257,137	278,610	346,568	364,765	370,463
8	$\bar{AF} = \alpha$ (Avg. Line 7)	259,360								
9	$(E - \bar{E})(AF)$ * (Line 4xLine 7)	-645,100	-739,800	-553,000	-306,300	180,000	529,300	1,005,100	1,386,200	1,741,400
10	$\sum (E - \bar{E})(AF)$ (Sum Line 9)	4,845,500,000								
11	$\hat{B}$ (Line 10 ÷ Line 6)	20.6								
12	$\bar{E}\ \hat{B}$ (Line 3xLine 11)	336,604								
13	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73
14	E (Line 2)	8,482	10,351	12,420	14,888	16,990	18,272	19,232	20,109	21,053
15	$\alpha - \bar{E}\hat{B}$ (Line 8-Line 12)	–77,244								
16	$E \times \hat{B}$ (Line 14xLine 11)	173,033	213,231	255,852	306,693	349,994	376,403	396,179	414,245	433,692
17	$(\alpha - \bar{E}\hat{B}) + (E \times \hat{B})$ (Line 15+Line 16)	95,789	135,987	178,608	229,449	272,750	299,159	318,935	337,001	356,448

10	11	12	13	14	15	16	17	18	19	20
'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
21,600	22,150	22,675	23,050	23,400	23,700	23,900	24,125	24,300	24,450	24,575
5,260										
28,100										
424,100										
,247,700										
'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
21,600	22,150	22,675	23,050	23,400	23,700	23,900	24,125	24,300	24,450	24,575
444,960	456,290	467,105	474,830	482,040	488,220	492,340	496,975	500,580	503,670	506,245
367,716	379,046	389,861	397,586	404,796	410,976	415,096	419,731	423,336	426,426	429,001

FORM M: EARNINGS ON INVESTMENTS

(*Indicates figures in thousands of dollars)

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9
1	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73
2	Total Taxes *	112.8	166.7	201.7	303.9	343.4	382.1	611.8	659.1	823.3
3	Interest Earnings	3,497	5,501	6,656	6,990	9,272	10,317	10,401	8,568	32,109
4	Earnings ÷ Taxes (Line 3 ÷ Line 2)	.031	.033	.033	.023	.027	.027	.017	.013	.039
5	Average Earnings (Line 4 ÷ n)	.027								
6	Projection of Earnings									

10	11	12	13	14	15	16	17	18	19	20
74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
911.0	977.6	1,109.8	1,247.6	1,392.2	1,544.3	1,704.0	1,871.3	1,963.5	2,233.4	2,428.3
24,597										
.027										
	26,395	29,965	33,685	37,589	41,696	46,008	50,525	53,014	60,302	65,564

FORM N: STATE AID BASED ON ENROLLMENT

(* Indicates figures in thousands)

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9
1	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73
2	Enrollment (E)	8,482	10,351	12,420	14,888	16,990	18,272	19,232	20,109	21,053
3	$\bar{E}$ (Avg. Line 2)	16,340								
4	$E - \bar{E}$ (Line 2-Line 3)	-7,858	-5,939	-3,920	-1,452	650	1,932	2,892	3,769	4,713
5	$(E - \bar{E})^2$ * (Line 4)^2	62,400	36,000	15,200	2,108	423	3,732	8,363	14,400	22,100
6	$\sum(E - \bar{E})^2$ (Sum Line 5)	234,800,000								
7	State Aid * (SA)	861.5	1,214.8	2,361.2	3,034.8	3,851.7	4,142.4	5,604.1	6,162.2	6,497.5
8	$\bar{SA} = \alpha$ (Avg. Line 7)	4,150,620								
9	$(E - \bar{E})(SA)$ * (Line 4xLine 7)	-6,805,900	-7,288,890	-9,208,700	-4,552,200	2,696,200	7,870,600	16251900	23416400	30538300
10	$\sum(E - \bar{E})(SA)$ * (Sum Line 9)	94130000								
11	$\hat{B}$ (Line 10 ÷ Line 6)	400.9								
12	$\bar{E}\hat{B}$ * (Line 3xLine 11)	6,550.7								
13	YEAR (Line 1)	'65	'66	'67	'68	'69	'70	'71	'72	'73
14	Enrollment (Line 2)	8,482	10,351	12,420	14,888	16,990	18,272	19,232	20,109	21,053
15	$\alpha - \bar{E}\hat{B}$ * (Line 8-Line 12)	-2,400.1								
16	$E \times \hat{B}$ * (Line 14xLine 11)	3,400.4	4,149.7	4,979.2	5,968.6	6,811.3	7,325.2	7,710.1	8,061.7	8,440.1
17	$(\alpha - \bar{E}\hat{B}) + (E \times \hat{B})$ * (Line 15 + Line 16)	1,000.4	1,749.7	2,579.2	3,568.6	4,411.3	4,925.2	5,310.1	5,661.7	6,040.1

10	11	12	13	14	15	16	17	18	19	20
'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
21,600	22,150	22,675	23,050	23,400	23,700	23,900	24,125	24,300	24,450	24,575
5,260										
28,100										
7,776.0										
1,212,800										
'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
21,600	22,150	22,675	23,050	23,400	23,700	23,900	24,125	24,300	24,450	24,575
8,659.4	8,879.9	9,090.4	9,240.7	9,381.1	9,501.3	9,581.5	9,671.7	9,741.9	9,802.0	9,852.1
6,259.4	6,479.9	6,690.4	6,840.7	6,981.1	7,101.3	7,181.5	7,271.7	7,341.9	7,402.0	7,452.1

FORM O: STATE AID BASED ON ASSESSED VALUATION

(*Indicates figures in thousands of dollars)

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9
1	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73
1a	Enrollment (E)	8,482	10,351	12,420	14,888	16,990	18,272	19,232	20,109	21,053
1b	Assessed Valuation * (AV)	2,136	3,157	3,784	5,772	6,468	7,191	11,641	12,394	15,578
1c	State Aid * (SA)	861.5	1,214.8	2,361.2	3,034.8	3,8517	4,142.4	5,604.1	6,162.2	6,497.2
1d	SA/E (Line 1c ÷ Line 1a)	101.6	117.4	190.1	203.8	226.7	226.7	291.4	306.4	308.6
2	AV/E (Line 1b ÷ Line 1a)	252	305	305	388	381	394	605	616	740
3	$\overline{AV/E}$ (Avg. Line 2)	478								
4	$(AV/E - \overline{AV/E})$ (Line 2-Line 3)	–226	–173	–173	–90	–97	–84	127	138	262
5	$(AV/E - \overline{AV/E})^2$ $(\text{Line } 4)^2$	51,076	29,929	29,929	8,100	9,409	7,056	16,129	19,044	68,644
6	$\sum (AV/E - \overline{AV/E})^2$ (Sum Line 5)	339,172								
7	SA/E (Line 1d)	101.6	117.4	190.1	203.8	226.7	226.7	291.4	306.4	308.6
8	$\overline{SA/E} = \propto$ (Avg. Line 7)	233								
9	$(AV/E - \overline{AV/E})(SA/E)$ (Line 4xLine 7)	-22,961.6	-20,310.2	-32,887.3	-18,342	-21,989.9	-19,042.8	37,007.8	42,283.2	80,853.2
10	$\sum (AV/E - \overline{AV/E})(SA/E)$ (Sum Line 9)	138,370.4								
11	$\hat{B}$ (Line 10 ÷ Line 6)	.408								
12	$\overline{AV/E} \cdot \hat{B}$ (Line 3xLine 11)	145								
13	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73
14	AV/E (Line 2)	252	305	305	388	381	394	605	616	740
15	$\propto - \overline{AV/E}\,\hat{B}$ (Line 8-Line 12)	38								
16	$AV/E \cdot \hat{B}$ (Line 14xLine 11)	102.8	124.4	124.4	158.3	155.5	160.8	246.8	251.3	301.9
17	$(\propto - \overline{AV/E}\hat{B}) + (AV/E \cdot \hat{B})$ (Line 15 + Line 16)*	1,194	1,677	2,012	2,844	3,296	3,636	5,481	5,812	7,158

10	11	12	13	14	15	16	17	18	19	20
'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
1,600	22,150	22,675	23,050	23,400	23,700	23,900	24,125	24,300	24,450	24,575
7,143	18,434	20,974	23,641	26,444	29,387	32,475	35,730	39,158	42,764	46,553
776.0										
360.0										
794	832	925	1,025.6	1,130	1,240	1,359	1,481	1,611	1,749	1,894
316										
0,256										
360										
3,760										
'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
794	832	925	1,026	1,130	1,240	1,359	1,481	1,611	1,749	1,894
324.0	339.5	377.4	418.6	461.0	505.9	554.5	604.3	657.3	713.6	772.8
7,819	8,373	9,419	10,534	11,677	12,893	14,173	15,488	16,889	18,386	19,930

[illegible] FEDERAL REVENUE

([illegible] figures in thousands of dollars)

LINE	VARIABLE NAME	1	2	3	4	5	6	7	8	9
1	YEAR	'65	'66	'67	'68	'69	'70	'71	'72	'73
2	Enrollment (E)	8,482	9,351	12,489	13,808	16,090	18,272	19,232	20,100	21,053
3	Cost *	4,062.9	5,216.9	7,164.2	9,795.4	12,200.6	14,325.2	16,866.5	19,540.5	21,294.6
4	Federal Revenues *	72.3	133.8	272.0	230.5	237.9	359.7	587.7	675.2	623.2
5	Costs/Student (Line 3 ÷ Line 2)	479	564	577	666	712	784	877	972	1,011
6	Revenue/Student (Line 4 ÷ Line 2)	8.53	12.52	6.224	16.82	12.98	19.66	30.557	33.60	29.59
7	Revenue/Student ÷ Cost/Student (Line 6 ÷ Line 5)	.0182	.0256	.0221	.0252	.0190	.0253	.03481	.0346	.0292

10	11	12	13	14	15	16	17	18	19	20
'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84
21,600	22,150	22,675	23,050	23,400	23,700	23,900	24,125	24,300	24,450	24,575
25,920	27,710	29,478	31,463	32,760	34,626	36,185	37,804	39,245	40,611	41,632
699.8	748	796	850	885	935	977	1,021	1,060	1,096	1,124
1,200	1,251	1,300	1,365	1,400	1,461	1,514	1,567	1,615	1,661	1,694
32.40	33.78	35.10	36.86	37.80	39.44	40.88	42.31	43.61	44.84	45.74
.0270	.027	.027	.027	.027	.027	.027	.027	.027	.027	.027